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BALLOTS FOR THE AM. SOC. C. E. election were issued this week on a perforated broadside sheet containing 8 ballots. In regard to the election Mr. JOHN MCLEOD writes us: "At the last monthly meeting of the Engineering Association of the South, held at Birmingham, Ala., Dec. 12, the seven members of the Am. Soc. C. E. present met and unanimously resolved to support the St. Louis ticket (ticket No. 3 of the sheet of ballots), and the same ticket was endorsed by the members of the Am. Soc. C. E. resident in this city (Louisville) at a meeting held on Dec. 17."

The same member and several others ask us to call the especial attention of members (which would seem to be done explicitly enough on the ballots themselves) to the fact that *dues for the year* 1890 *must be paid*, and *the ballot envelope must be endorsed on the back by the voter*, or the ballot is informal and void.

A RIVER POLLUTION COMMISSION for New Jersey was recommended by the State Sanitary Association at its late meeting, and a bill providing for such a commission will probably be presented to the next Legislature. This commission would be a successor to the now defunct State water board, but it would have additional powers.

THE MEMPHIS BRIDGE, says the *Appeal*, of that city, is being pushed. Falseworks are being erected for some of the superstructures, and the foundation pits of the Memphis abutment are being dug. A large amount of the bridge iron is now on hand, and erection will probably begin in about one month. Mr. J. M. HEISKELL, Assistant Engineer, is quoted as fixing 1892 as the year of completion for the bridge.

THE CHIGNECTO SHIP RAILWAY WORKS are now well advanced, the roadway proper being about finished, about 10% of two large cuttings being all that remains undone. The track is laid from the southern dock for 13 miles, or to within 4 miles of the northern dock. The track, as previously noted, is an ordinary double track laid with 110-lb. rails, 18 ft. between centers, with 9-ft. × 7 × 12-in. ties, laid 2 ft. centers, the two ties at each joint being 27 ft. long, to connect the two tracks, and thus preserve exact gauge for the cradle. The locomotives run on one track only, of standard gauge, two locomotives being used for each cradle. There are no turn-outs, but traverse tables at each end; frogless switches riding the rails being used for switching locomotives. Rock ballast, 14 ins. under the ties, is used throughout. Work on the lifting docks is in a very forward state, so as to make it fairly certain that the work will all be completed in 1891. The pumping machinery at the southern end is in place, and the building for it completed; at the other end, the same work is about half completed, and is likely to be complete by July 1. At least 1,500 men will be employed on the works next summer.

TANK LOCOMOTIVES for the Chignecto Marine Transport Railway (the ship railway across the isthmus at the head of the Bay of Fundy) are to be built by the Canadian Locomotive & Engine Co., of Kingston, Ont. They will have eight coupled driving wheels 47 ins. diameter, and no truck; the total weight in working order will be 180,000 lbs.; cylinders, 22 × 26 ins. The boiler is of the straight top type, 59 ins. diameter; there are 253 tubes 2 ins. diameter. Heating surface of tubes, 1,781 sq. ft.; of firebox, 137 sq. ft.; total, 1,878 sq. ft. Grate area, 29 sq. ft. The capacity of the tanks will be 3,000 imperial galls., or 3,636 U. S. galls. Two of these locomotives abreast are to haul a vessel on the cradle, weighing together 2,500 gross tons, at a speed of 10 miles per hour, on a level and straight track. The cradle will be carried on 20 four-wheel trucks. The line will be 17 miles long, and will be laid with steel rails weighing 110 lbs. per yd. The railway was described and illustrated in ENGINEERING NEWS, Sept. 7, 1889; the rail section was also shown in that issue, and the cradle and lifting dock in the issue of Sept. 28, 1889.

THE IMPROVEMENT OF PHILADELPHIA'S HARBOR is to be commenced, and bids are called for by the U. S. Engineer's office of Philadelphia, for Feb. 12, 1891, for removing Smith's, Windmill and Petty's islands in the Delaware River, and the shoals adjacent thereto. The general project of improvement contemplates the formation of a channel 2,000 ft. wide, from Kaighn's Point to Fisher's Point, with a mean-tide cross-section of about 55,000 sq. ft. The general depth in this channel will be 26 ft. The ultimate cost of the dredging required is estimated at $3,500,000, with $390,000 now available. The work now to be let includes the removal of piles and revetment, extending over a length of about 18,000 ft., and the dredging of 700,000 cu. yds. at Windmill Island, 300,000 cu. yds. at Smith's Island, and 1,000,000 cu. yds. at Petty's Island.

THE BLACKWALL TUNNEL UNDER THE THAMES proposed by Sir BENJAMIN BAKER, would have an outside diameter of 27 ft. and an inside diameter of 23 ft., as contrasted with the 10 ft. of the Southwark tunnel just completed. This tunnel would be an iron tube built in segments and excavated by means of a shield. The soil to be penetrated is clay, gravel and sand, without mud. The tunnel would be lined with 2 ft. of brickwork, and space would be afforded inside for two lines of rails and a clear height of 18 ft. for vehicles.

A LONG SUBMARINE PIPE was successfully laid on Dec. 19, at West Superior, Wis. The Superior Water, Light & Power Co., extended its 6-in. intake pipe 2,950 ft. into Lake Superior, by jointing the pipe while suspended in slings on piles above the water. The sling lashings were cut simultaneously at selected points and the weight tore away the remainder and the long tube "dropped squarely into position on the bottom of the lake."

THE LARGE INTAKE CRIB in connection with the new Milwaukee, Wis., water-works tunnel and intake pipe was successfully placed by contractor JOHN O'NEILL, on Dec. 24. The crib was towed into place in Lake Michigan, 3,147 ft. due east from the shore, held in position by four cables attached to anchors, and sunk by pumping water into its six water-tight compartments. The crib is 50 ft. in diameter, placed in 25 feet of water, and before being lowered into place it was filled with concrete so that the water line was but nine feet from the top. An illustrated description of the crib, tunnel and pipe extensions appeared in ENGINEERING NEWS for Oct. 25, 1890.

THE TOPEKA, KAN., WATER POWER DAM is practically commenced. The contractors are Messrs. Comstock & Williams, of Kansas City, and Capt. JAMES ANTHONY is the chief engineer of the company. The time set for the completion of the work is June 1, 1891.

THE AMERICAN RIVER DAM, intended to furnish water power for Sacramento, Cal., was finished on Dec. 20. This dam has been built by convict labor during the last two years, and the same force will now be put to work upon the canal and power house required. The dam is built of stone.

THE PACIFIC COAST DRY DOCK has been located at Port Orchard, on Puget Sound, by the commissioners appointed for that service by the government. The 1,715 acres secured cost $36,638, and the site is regarded as peculiarly favorable and accessible by railways.

THE PRINCE EDWARD ISLAND TUNNEL SCHEME has been revived by the successful completion of the St. Clair tunnel. The magnitude of the work there contemplated, however, exceeds that at the Detroit River as 32,000 ft., including approaches, exceeds 11,705 ft. The tunnel is doubtless badly needed; but the cost is estimated at from $5,000,000 to $20,000,000. The first estimate is seemingly absurdly low for such a work, and anything near the latter amount will be difficult to obtain from the Dominion government.

THE UNITED STATES PROJECTILE CO., with a capital of $500,000, was incorporated at Albany this week. It is to manufacture shells and projectiles of iron and steel at New Utrecht, Kings Co., N. Y.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was the derailment on Dec. 24 of a fast train on the New York, New Haven & Hartford R. R. The accident occurred about 1½ miles east of Leetes Id. at a point where the track crosses a salt meadow by an embankment. The engine passed over the broken rail, but three of the cars rolled down the bank onto the sand. No one was seriously injured.

THE DRIVING WHEEL of a Baltimore & Ohio engine broke Dec. 28 while the engine was hauling a fast train near Tiffin, O. One side of the cab was wrecked, but the fireman escaped injury and the locomotive did not leave the track.

BRIDGES have been wrecked by the recent floods in British Columbia.

Concerning Cast-Iron Coated Water Pipe.

In discussing the paper of Mr. THOMAS W. YARDLEY, of Chicago, Ill., on "Specifications for Cast-Iron Coated Water Pipe," read at the last Washington meeting of the American Institute of Mining Engineers, Mr. J. C. BAYLES made the following remarks:

As a purchaser or user of cast-iron pipe, or any other kind of pipe, I should not be satisfied with so much of Mr. YARDLEY's specifications as relates to coating and testing. I should in every case demand that the pipe be tested before it is coated. This is especially true of cast-iron. Any form of coating suitable for a pipe which is to be shipped and handled will conceal a multitude of small defects in casting, such as blow-holes, sand-holes, and even small shrinkage cracks. In 1887, the Commissioners of the Health Department of New York City found it necessary, in the discharge of their responsibilities relative to the plumbing of new buildings, to amend the plumbing code by the insertion of a clause forbidding the use of dipped, varnished or painted pipes. The reason for this action was the discovery that even a thin coating of very little value as a protection to the iron, could be made to conceal so many foundry defects, and permitted so much carelessness on the part of the makers, that sound pipes were the exception rather than the rule. The value of such a coating in enabling pipes to pass a test is shown in much of the light-riveted pipe in the market.

I have seen a pipe put together with small cold rivets, headed by pressure, which, after coating with coal tar and asphalt, has shown in the testing machine a capacity to carry without leaks a test pressure much higher than Mr. YARDLEY prescribes for the strongest and heaviest cast-iron pipes he mentions. Before coating, the seam would have shown a continuous leak from end to end. The fact that a coated pipe will hold water under a considerable pressure in the testing machine seems to me to speak more for the coating than for the pipe. A cork inserted in the end of a gun-barrel will usually be found in place when the explosion of the charge has burst the barrel. Experiments show that a plug of mud, or even of snow, will do the same. As a manufacturer of pipes, I should be very much pleased to have consumers specify that none shall be tested until they have been coated. We should have very few wasted.

For cast iron-pipes the test pressures prescribed by Mr. YARDLEY seem to me much higher than is necessary. The calked joint is not adapted for high pressures, and cast-iron pipe is seldom employed under pressure greater than a lead calking will stand. It is not unusual in water-works practice for the lead to blow out of pipe joints at pressures much below those which the pipe will carry safely and comfortably. This is especially true if opportunity is offered for such changes of temperature as will produce a measurable contraction and expansion with the changes of the seasons. The strength of the pipe cannot be greater than the strength of its joints; and with the hub-and-spigot connection the usefulness of cast-iron pipes as a pressure conduit has well defined limitations. In buying it for any purpose for which that kind of pipe is adapted I should be content with half the test pressures prescribed by Mr. YARDLEY, but should insist on having the test made before the pipe was dipped—and, for that matter, I should require a very much better coating, after testing, than a coal-pitch varnish applied at 300° F.

Mr. YARDLEY, in replying to Mr. BAYLES, said: Cast-iron pipes for water-works were first used by the New River Water-Works Company, of London, England, in the year 1810. In 1822 the greatly increased demand for water made it necessary for the company to enlarge the mains. In taking up some of the pipe laid in 1810, many were found rusted so much that they were unfit for future use. This fact coming to the notice of Dr. ANGUS SMITH, he commenced a series of experiments in the preparation of a coating or varnish to be applied to the inner and outer surfaces of pipe to be used for carrying water. His experiments demonstrated the fact that his varnish would not stop the rust when it had once commenced, notwithstanding the rust was covered by the varnish. It was then he adopted the system of coating pipe as soon after cleaning as was practicable, and requiring the pipe to be heated to 300° F. before immersing it in the bath.

In 1858, some of the pipe being taken from the trenches, in which they had been under ground for 30 years, the varnish was found hard and bright and the pipes that were broken gave no sign of rust, So satisfactory was this result that the English Government gave a patent therefor to Dr. ANGUS SMITH, and his process has since been used by all makers of cast-iron pipe for water-works.

In making my specifications I have followed what I believe to be the recognized practice of the best hydraulic engineers of this country, and I know I have the endorsement of many. I was not aware, until Mr. BAYLES made the statement, that tar-coating possessed so much strength. If he is correct, would it not be more economical for water-works companies to have the iron shell of the pipe much thinner than now used, and give the pipe greater thickness of tar?

In regard to the hydraulic test, I have the best authority for the pressure required for all pipe above 16 ins. diameter. The increased pressure is specified for the smaller diameters, because the water-test is the only one used. It would be very inconvenient, as well as quite expensive for the makers, if they were required to take test-bars for so great a number of pipe as the foundry could turn out daily of the smaller sizes.

The Cement Laboratory of the St. Louis Water-Works Extension.

BY S. BENT RUSSELL C. E.

It is a comparatively simple matter to test the strength of a piece of metal, stone or brick. We have but to crush it, pull it in two or distort it in some manner. To test a cement, however, which comes to us in the form of a fine powder, and determine what strength it will have after other substances have been chemically combined with it, a long time elapsed and its identity all but lost, is essentially a different problem. It is doubtful if any method of testing will ever be arrived at which will give values as absolute as those obtained with other materials of engineering.

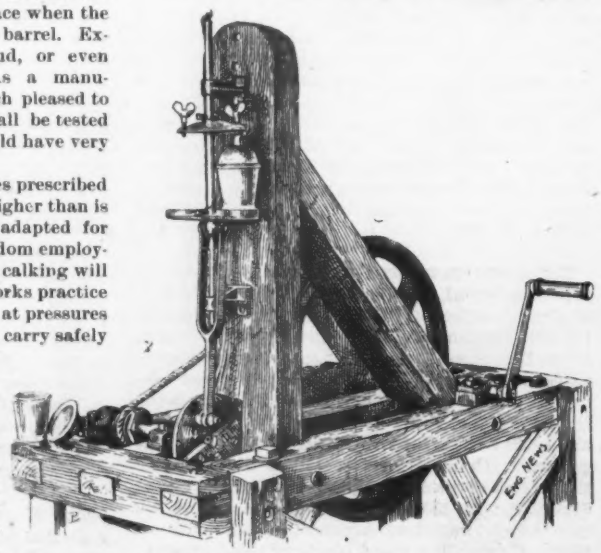


FIG. 1.—VIEW OF JIG.

With the present condition of things the only safe method, for one who has not had considerable experience in the art, is that of simultaneous comparative tests. With this method almost all of the effects of incidental conditions should be eliminated. Comparing the cement under examination with one whose quality is known, very little skill is required to get results of practical value. In testing cement for large works, engineers usually have two ideas in view. The first is to determine whether the quality is such as to insure the success and durability of the work in which the cement will be used. With this purpose only, one might dispense with the tensile test entirely in the majority of cases, especially if the *simultaneous comparative* method be adopted. By testing the fineness and observing the behavior of the neat cement when made into cakes and exposed to air and water as described by Gen. GILLMORE's committee of the American Society of Civil Engineers, one can judge of the cement's quality well enough for most cases in practice.

The second test is—to put the quality of the cement on record. This is most important on large public works. Where great interests are involved it is necessary not only to know things, but to show them. It is sometimes difficult to *prove* that a cement is of inferior quality. One high test is good evidence that a cement possesses hydraulic qualities, but one low test is no evidence of inferiority. With our present methods the best cements will occasionally give a weak briquette in the most careful hands.

It is now nearly six years since the report of the American Society of Civil Engineers' committee was presented. Since that time the system of testing recommended by them has doubtless been given a thorough trial by many engineers. It would seem about time to inaugurate a complete discussion of their report to the end, that a year or so hence the committee might be reappointed to revise and strengthen it. If the system has given general satisfaction, such a discussion would add greatly to its authority.

In the St. Louis Water-Works Extension the American Society of Civil Engineers Committee's report has been taken as the basis for all cement testing. The longer one works with this system the higher is his appreciation of the work of that committee, and the greater his admiration for the manner in which they pass silently by the numerous pitfalls which beset the path of the young and hopeful experimenter. One must needs have courage to criticise the document, both on account of the wisdom contained in it, and of the list of weighty names subscribed thereto.

A slight omission, or what would seem one, that might be noted, is that the report does not clearly state on what kind of surface the briquette should rest after being taken from the mold and before immersion.* Another point that might be raised is, that no mention is made of chemical tests, which are considered valuable by some authorities. In order to save space it is assumed in this article that the reader is familiar with the report above mentioned.

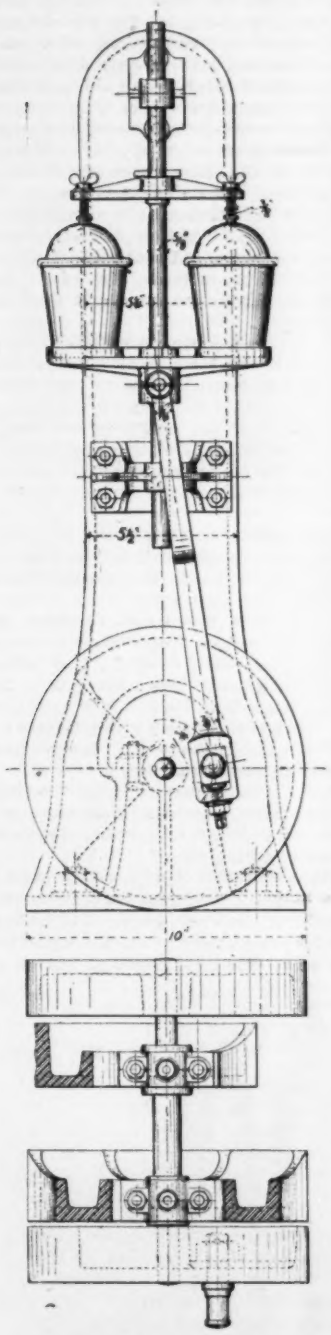
By far the largest part of the cement tested in the laboratory to be described is Portland. We will begin with taking the samples, one of which is usually taken from every third barrel. Most of the cement arrives on the work in large shipments of from 1,000 to 5,000 barrels. The barrels are numbered consecutively in groups of three, *i. e.*, three barrels receive the same mark, thus: 1235,1235, 1235, 1236, 1236, 1236, 1237, 1237, 1237, etc. One barrel of each group is tapped, and a sample taken and put in a paper bag marked with the number of the barrel. The group of three is treated as one barrel.

It has been found best to sample thus in regular routine, as confusion is avoided and time saved in the end. When the cement is considered worthy of confidence, only the even number bags are tested, the odd numbers being reserved. When that is done, if the tests run fairly uniform the reserved bags are not tested. As one test cannot prove the inferiority of a barrel, if 80 or 90% of the tests for any one shipment test above the required strength, the bags testing low are given another trial. For this purpose each sample is taken large enough for two briquettes.

The bags containing the samples are arranged in order on long shelves in the laboratory and we are now ready for gauging or mixing. As our specifications name a neat test most of our tests are with cement and water only. Almost all neat cement mixing in this laboratory is now done with the aid of a machine known as the "jig," which is shown in Fig. 1, taken from a photographic view of the jig now in use. The idea of the machine is a very simple one.

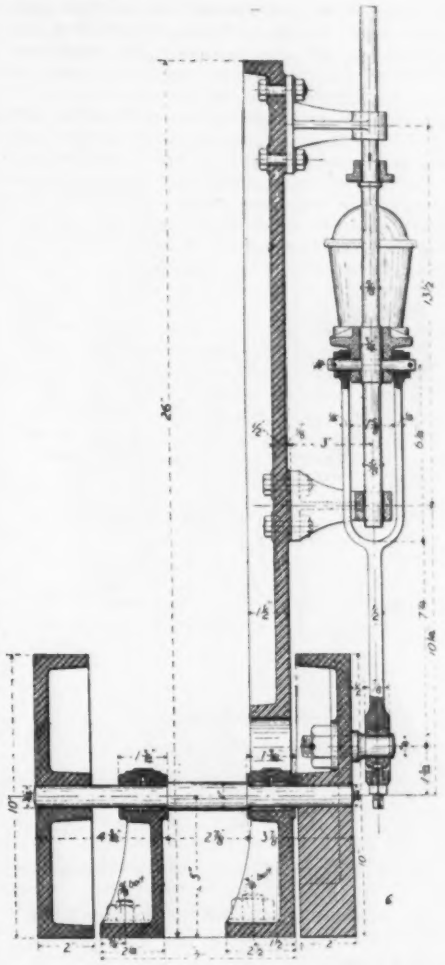
Sufficient cement to form one briquette is put into a cup, the proper proportion of water is then poured

*That this is important is indicated by recorded experiments. See CONNOR on Substructure of the Cairo Bridge-Journal of Ass'n. of Eng'r. Soc., June, 1890.



Front Elevation and Sectional Plan.

FIG. 2.—JIG.



Sectional Side Elevation.

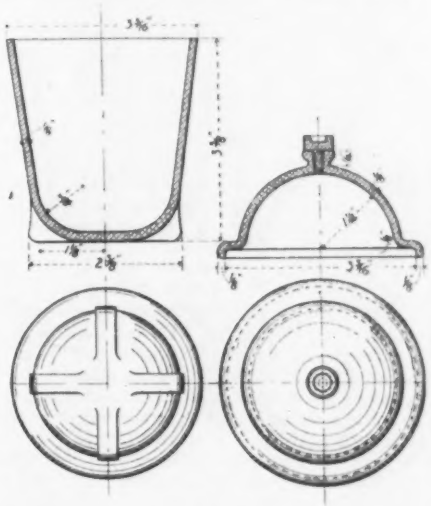


FIG. 3.—Jig Cup.

on the cement and a tight fitting cover put on. The charged cup is then shaken violently at the rate of from 500 to 800 oscillations per minute until the cement and water are thoroughly mixed. Fig. 2 is drawn to scale and shows the essential parts of the jig. The machinery for revolving the fly wheel shaft is not shown.

In the present machine this shaft carries a 2-in pulley made of leather washers tightly clamped together and turned to a grooved face. This pulley is driven by a ½-in. cotton rope, which is driven in turn by a 26 in. grooved wheel revolved by a hand crank, as may be seen in Fig. 1. Fig. 2 was drawn for a machine yet to be built, but the important features are the same as in the machine now in use. The old machine has not so much fly-wheel as shown in Fig. 2.

Fig. 3 shows the brass cup with cover which receives the charge. The inside of both cup and cover should be finished very smooth, so that the cement will not adhere, and the cover is ground to a fit. A steel plug in the top of the cover is needed to withstand the abrasion of the tightening screws. The reciprocating parts of the jig are made as light as possible and counterbalanced. The high speed shaft is of steel, with long bearings of small diameter, and ample provision should be made for lubrication.

The usual test is made as follows: Two cups are wiped out and 135 grains of Portland cement are weighed out into each. The cement is passed through a coarse sieve before weighing to remove chips and paper; 8 drachms of water are then measured out in an ounce glass and poured into each cup. The two cups are then covered and set in place on the jig and clamped with the thumb screws. The crank is then turned rapidly for about a minute and a half. The fly-wheel shaft is then driven at the rate of something over 500 revolutions per minute. The covers are then removed and the cement is found to be formed into a plastic ball resting at the bottom of the cup. This ball is easily shaken out into the palm of the hand and is then pressed into the briquette mold with the fingers and smoothed off with a palette knife. The cups are then quickly wiped out clean for the next pair of tests. The plastic ball formed by the jig should be quite wet on the surface, but of a consistency like soft putty within.

Taking a turn at the jig is pretty severe work while it lasts and tests a man's wind thoroughly, but it is less irksome than mixing by hand. Two men with the jig can turn out two dozen briquettes an hour with ease, which is as much as they could do with hard work by hand, if the mixing be thorough. The effect of jigging seems to be a thorough compacting of the mixed cement, so that with the same plasticity we have a slightly smaller proportion of water required, and a greater weight of cement, by about 5%, is needed to fill the mold than with hand mixing. As might be expected, the tensile strength of the briquette is somewhat increased by this method of mixing.

One advantage over hand mixing is that the cement is not spread and worked while exposed to the air on a table or in a basin, so that no water is lost by evaporation in mixing, and we thus get the same plasticity with the same proportion of water on an extremely hot, dry day as we do on a cool, damp day, and avoid a great source of annoyance.

To obtain results approaching precision the cement should be weighed and the water measured with great care. Each cement should have a preliminary test to determine the proper proportion of water required to secure the best results. In this laboratory, however, almost all Portland cements are tested with the proportions given above, *i. e.* 20% of water. The machine above described was devised during the past summer, and the first briquette was made with it on Oct. 2, 1890. About 1,500 briquettes have been made with it up to time of writing. The results have been so satisfactory that hand mixing has been almost abandoned in this laboratory.

New brands of cement and cements not showing a high neat test are subjected to a 28-day sand test—one part of cement to three parts of sand by weight. These tests also are usually made with the aid of a machine.

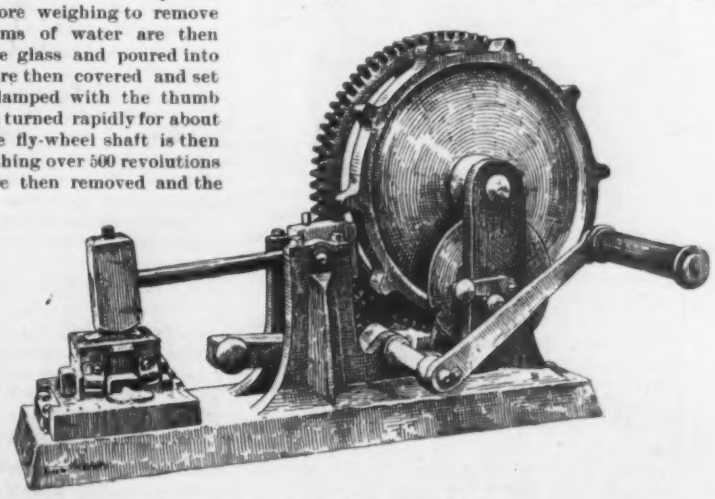


FIG. 4.—TRIP HAMMER.

Fig. 4 shows the *trip hammer*, which is a reproduction of a machine brought over from Germany during the summer of 1890. The trip hammer is operated by a hand crank and is provided with an automatic counting gear which stops the movement after 150 blows. The hammer falls on a plunger

shaped to roughly fit the briquette mold. This plunger passes through an iron block which rests on the briquette mold and conforms to it in outline. The test is made as follows: The ingredients, cement, sand and water, are quickly mixed in proper proportion by hand until the mixture is apparently uniform. By the use of a funnel of peculiar shape, they are then poured into the mold, the plunger set on and the hammer started and turned at a uniform speed until it stops automatically. The plunger and cap are removed, and the briquette is then shaved off with a knife and at once removed from the mold.

If too much water is used in this test the mortar will squeeze out of the mold and fly in all directions under the hammer. If too little water is used the briquette will fall to pieces when removed from the mold. This automatic regulation of the water tends toward uniformity in results. The effect of the severe pounding is probably to force the sand and cement to distribute themselves uniformly throughout, and thus it takes the place of the most thorough mixing.

Neat briquettes are removed from the mold as soon as they have set hard enough to be marked with a soft pencil.

The laboratory is provided with a small cupboard in which all briquettes are kept until ready for immersion. This cupboard is furnished with 6 movable wooden shelves about 22 ins. long and 4 ins. wide, each holding 20 briquettes on edge. These shelves are used as trays on which the briquettes are taken to and from the cupboard. A cup containing a saturated sponge keeps the air moist in the cupboard. After the proper time has elapsed the briquettes are immersed in water. If they are to be broken in 28 days or less they are set in galvanized iron pans 34 ins. long, 22 ins. wide and 4in. deep, and kept covered with water. If the briquettes are to be kept longer than one month they are placed in two-gallon stone jars covered, sealed and labeled, and the jar is not opened until the briquettes have reached the age for breaking.

The room containing the cupboard, pans and jars is heated by a hard coal, base-burning stove, and is provided with a good maximum and minimum thermometer. A man sleeps in the house, and an effort is made to keep the minimum temperature of this room above 60° F. Briquettes which have been exposed to a lower temperature are regarded with suspicion.

The briquettes prepared and guarded as above described are now ready for breaking. The form of briquette known as the American Society standard is so modeled that if three briquettes out of four break in the smallest section one may be sure they are being fairly treated.

Gen. GILLMORE'S committee recommends that briquettes not breaking in the smallest section should not be counted. Experience on the St. Louis Water Works Extension, however, would indicate that a fairer way is to judge by the majority of the breaks. When a majority of the briquettes break at the gripping points of the clips a center break would seem to indicate a local weakness. This is shown by the fact that with imperfect clips the center breaks often have the lowest breaking strength.

When a majority of the briquettes break at the gripping points of the clip the observer may regard all the tests with suspicion. He should endeavor to locate the trouble and remedy it.

Fig. 5 shows a scale drawing of the clip used in this laboratory. It is made of brass with steel pin connections, and the cone point on which the testing machine pulls is of steel. It should be well made, with the pins carefully fitted so they will work easily in their bearings, but with sufficient friction to hold the parts in position while the briquette is being placed in them. To get the best results the pins should be kept clean and lubricated, and the *gripping points* of the clip should be touched with grease after every two or three tests. It would seem that breaking in the gripping points in the ordinary solid clip is often caused by the sliding of the metal over the cement due to the briquette not having been set in perfect line with the clips.

The two brass index points on the inside of this clip show at once if the clip is not set straight, and these points should be observed from time to time while the strain is on. The principle of this clip is readily seen. The upper cross bar forms a perfect balance so that the pull on each jaw must of necessity be equal. The cross links prevent the jaws from spreading, and as they are parallel to the upper cross bar they can only balance the horizontal components due to the wedging action of the briquette. Other balancing clips have been tried but always with the jaws rigidly connected, and I know of none where this perfect balance at the gripping points has been secured. In simplicity this clip would seem to compare favorably with any of them.

This clip can be readily attached to the Riehle testing machine. It was devised by the writer last January and has been in constant use since April,

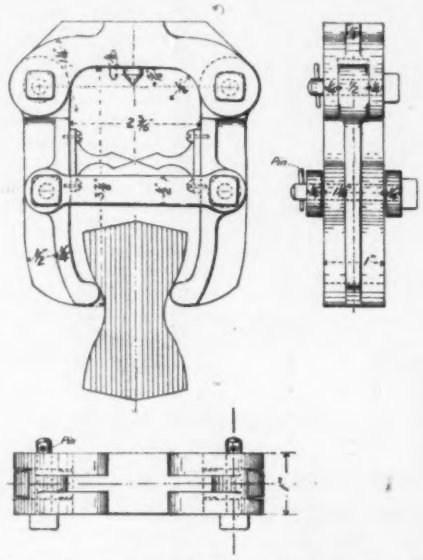


FIG. 5.—Elevations and Plan of Cement Tester Clip.

1890. The results obtained with it have been fairly satisfactory and the percentage of *clip breaks* has been small compared with that obtained before this clip was used.

New brands of cement are usually subjected to a chemical test which, however, is made at some chemical laboratory in the city. Sometimes a complete quantitative analysis is obtained and sometimes only magnesia and sulphuric acid are determined, as these are regarded as the most suspicious component.

Although perhaps not properly included under the title of this article, I will here note an item that may be of interest. I am informed by one of some authority on cement testing that a simple and rapid test to determine whether a lot of cement has been damaged may be made by finding the *loss by ignition* in a sample of the cement in question compared with the loss by ignition in a sample of fresh cement of the same make. If the loss be much greater in the former it may be taken as good evidence that the cement has deteriorated. Much less time is required by this method than by the shortest tensile test, and the apparatus necessary will be found in every chemical laboratory.

In addition to the apparatus above described the laboratory of the St. Louis water-works extension is provided with the usual appliances for sifting, measuring and weighing. Six large tin flour cans, holding about half a barrel each, have been found useful for storing sample lots of cement of well-known brands to be used in making comparative tests. The laboratory is located near the half-way point on the new 7-mile masonry conduit, and all cement used on the extension is tested here.

The Sewerage System of West Troy, N. Y.

The village of West Troy, N. Y., had a population of 8,820 in 1880 and a population of about 13,000 in 1890. Water-works were built in 1873-6 by a private company. A sewerage system was constructed by the village in 1886-9, of which Mr. CADY STALEY, of Cleveland, O., was Chief, and Mr. GEORGE S. PIERSON, of Kalamazoo, Mich., was Constructing Engineer. From the report of the engineer we abstract the data below and reproduce the accompanying illustrations.

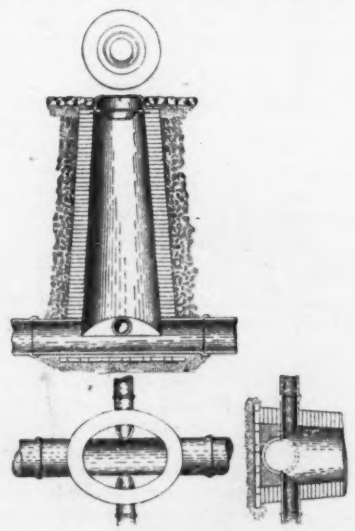
The village of West Troy has a Hudson River frontage of about two miles and extends back from the river about half a mile. The ground rises gradually from the river, the greatest elevation above datum, or low water, being only 65 ft. Naturally the village is well adapted for the construction of a sewerage system at low cost, as it is easily divided into districts which can be sewered with small pipe, laid in direct lines to the several outlets into the Hudson river. But the construction of the system was complicated and its cost increased by the Erie Canal, which runs through the village nearly parallel to, and about 800 ft. from, the river, necessitating 7 canal crossings, and causing difficulties mentioned below. In addition, the canal has two branches leading to the river and there are two large basins.

Besides the canal a stream called Dry River extends through the town, in an irregular but generally diagonal course. A few private sewers had been draining into this stream for some time, much to the detriment of the health of the village, the stream, as its name implies, being nearly dry in the summer, so that the sewage would stagnate in pools and smear the banks of the stream at every rain storm.

The water in the canal is about level with the natural surface of the ground near by and thus the natural drainage towards the river was intercepted and the land in some parts of the village water-soaked, especially where rock cropped up and formed natural basins. This difficulty was met by laying 3-in. drain tiles, 48,296 ft., and connecting them with the sewers. These drains have lowered the surface water from 3 to 5 ft. in some parts to the village. In some localities it was necessary to carry away storm water in the sewers, but generally the separate system was employed.

The material excavated from the trenches consisted of gravel, sometimes containing large boulders, clay and rock, from soft shale to argillaceous, seamed with quartz.

The village is divided into 9 sewerage districts, all but three of which have separate outlets. The outlets are of iron, and are protected by timber cribs loaded with stone, except when the outlet is at the face of a dock. The total length of sewers at the



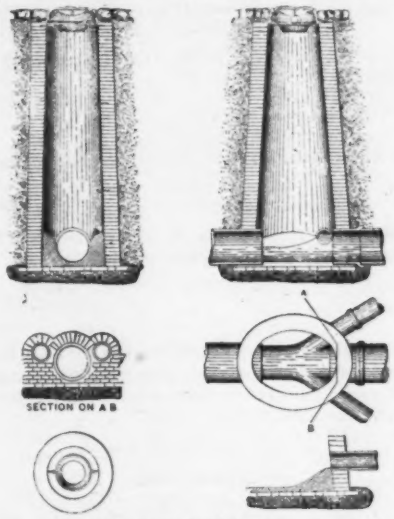
Manhole, Right-Angled Connection

time of completion, July, 1889, was 96,319 ft., or 18.8 miles. The pipe is of iron, varying in size from 18 to 6 ins., with but little below 8 ins. in diameter. As has been stated, there are 48,926 ft.; or over 9 miles, of 3-in. drain tile. The depth of trench excavation varied from 6 to 18 ft., with but little above 14 and but 42 lin. ft. above 16 ft. in depth. There was but little rock excavation. In some places pumping was required to keep water from the trenches. At one point the water rose 6 ft. in the trench, and was kept down with difficulty by means of a 6-in. centrifugal pump. The trench here was heavily sheet-piled and was kept open in sections but 25 ft. in length.

The cost of the sewers in the various districts ranged from $38,413 to $2,460, the total cost being $95,242, not including the operating mechanism of

the flush tanks, land damages, engineering and similar expenses, which increased the total to $112,940, or $1.18 per lin. ft.

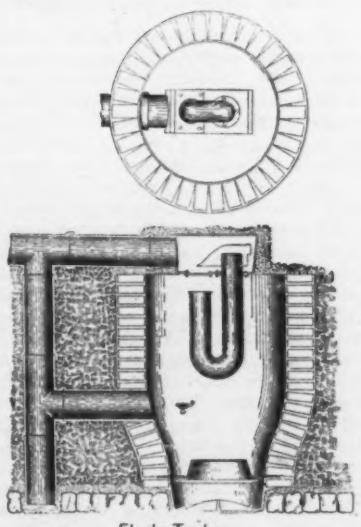
The aggregate daily capacity of the various districts is 3,940,000 galls. of sewage proper and 2,000,000 galls. of sub-soil and storm water, principally the latter. This provides disposal for 75 galls. per capita for a population of 52,530, or about four times the present population. On the above basis, according to the engineer's report, in no case will the



Manhole, Acute-Angled Connection.

sewers be filled to more than 71-100 of their diameter at the time of average maximum daily discharge.

Manholes are built at all junctions, and generally at changes in direction. The majority have right-angled connections, with a special form of bottom, the latter said to be somewhat similar to the English form. The engineer states that this form is advantageous when the sewers are small, the streets and alleys narrow and the cuts deep. The right and acute-angled forms are both shown in the accompanying illustrations. The contract price was $38 per manhole.



Flush Tanks.

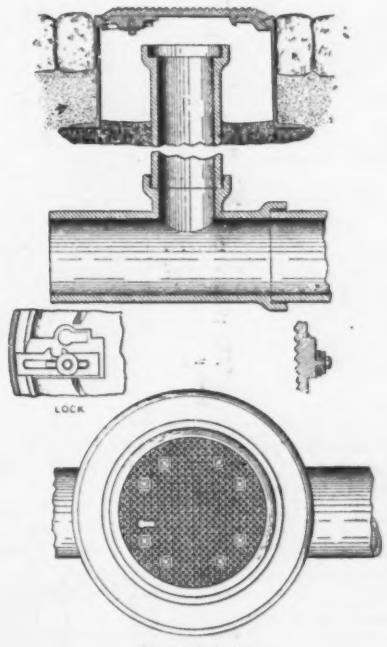
There are in use 91 automatic flush tanks of the Van Vranken type. They are designed to discharge 145 galls. once in each 24 hours. Their time of discharge varies from 10 to 15 seconds, according to the grade and capacity of the sewer. Their construction and operation are shown by the accompanying plan and section. The tank beneath the longer limb of the 6-in. siphon is tilted when the water outside the siphon rises sufficiently high to cause an overflow down the longer limb and the filling of the tank. The siphon then discharges the bulk of the water in the tank until the seal of the longer limb is broken. The covers of the tanks are perforated, and ventilation is secured by connecting the sewers with the tanks at a point of the water line. The flush-tanks cost $40 each for construction, and nearly $20 each for the operating mechanism.

There are 6 flushing inlets in the entire system, with a single exception one for each crossing beneath the Erie canal. An iron pipe of large diameter connects the canal with a manhole, and is provided with a gate, which is usually closed. Their principal use is for cleaning the lower end of the mains after high water in the Hudson River, and from the inlets these mains can be filled to the crown with water from the canal.

The fresh air inlets and locks for the same are sufficiently explained by the illustrations. Their number is not stated. Handholes were placed, generally, 100 ft. apart. They were formed by cutting, at proper intervals, a piece out of the top of the sewer pipe and replacing it, to be removed when desired.

The sewerage system was built under the direction of seven commissioners, of whom Mr. P. A. ROGERS was President, and Mr. J. A. HARMON, Secretary. Mr. EMMETT FLAGLER was Contractor.

The rules and regulations governing the making of connections with the sewerage system are unusually good, and also have the merit of being brief and



Fresh Air Inlet.

concise. They were adopted by the commissioners June 18, 1889, and are as follows:

SEC. 1. Application for permission to connect with the public sewers must be made in writing to the Superintendent of Sewers, JOHN MOORE, by the owner of the property or his authorized agent. Such application shall give the precise location of the property, the name of the owner, the name of the person employed to do the work, the object for which such connection is desired, and shall be made at least two days previous to the opening of the street.

SEC. 2. No person shall connect any open gutter, cesspool or privy vault with any public sewer, or any private sewer connecting with or emptying in the public sewers.

SEC. 3. No person shall deposit or cause to be deposited any garbage, offal, filth or liquid substances into or upon any manhole, lamp-hole, flush tank or sewer opening.

SEC. 4. The Superintendent of Sewers shall have power to disconnect any or all private sewers from the public sewers through which substances are discharged which are liable to injure the sewers or to stop the flow of the sewage.

SEC. 5. The opening or tapping of the public sewers, the connecting of the pipe of private sewers, and the laying of the same, shall be done under the personal supervision and control of the Superintendent of Sewers.

SEC. 6. All fixtures connected with private sewers leading to the public sewers shall be provided with suitable traps and strainers to prevent the introduction of improper substances into the sewer.

SEC. 7. The Superintendent of Sewers shall have the authority to enter upon any premises, at reasonable hours, for the purpose of examining all connections to private sewers emptying into the public sewers.

SEC. 8. No connection shall be made to private sewers which connect with the public sewers without the consent of the Superintendent of Sewers.

SEC. 9. No property outside of the village limits shall be allowed drainage or sewage connection in any way with the public sewers.

Should the Office of County Surveyor be Abolished?

A correspondent writes to solicit our advice and aid, by references and precedents, in an attempt he is now making to have the elective office of County Surveyor abolished in his section. He would propose instead, that it be compulsory for every surveyor who wishes to practice to either pass an examination, or to produce satisfactory evidence of his qualifications as a surveyor, and then to obtain a license, give bonds and become a State surveyor amenable to the State courts. His efforts to accomplish this end have so far failed, and he gives as one reason the difficulty of persuading politicians to abolish an office that can be assessed for campaign purposes.

We submitted this letter to Mr. F. HODGMAN, of Climax, Mich., Secretary of the Michigan Engineering Society, and publisher and author of various well-known surveying text-books. We knew that Mr. HODGMAN could speak from experience, and, in our opinion, his reply fully and clearly answers, not only this, but other similar correspondence coming to us.

After referring to the fact that surveyors in various states have been, for 20 years or more, trying to secure similar results and have met with a similar fate, Mr. HODGMAN says:

> The fact is, there is a deep rooted conviction in the minds of a very great majority of the people in those states which have County Surveyors that they want just such an officer of their own selection to settle their boundary questions, rather than go to law about them, just as much as they want a judge to decide their law suits. The County Surveyor may not be as competent as many another, but they prefer to be their own judges of that, and he is the man of their own selection.
>
> No matter what legal authority the County Surveyor does or does not possess, as a matter of fact, he is chosen by the interested parties, in effect, to act as arbiter of their differences. In this way he probably peaceably settles ninety-nine boundary cases where the courts settle one. Therefore, when surveyors ask that the office be abolished and every one of them who is competent be allowed to share the business, the people look at it very much as they would if the lawyers were to say: "Gentlemen, we are every one of us as good lawyers and honest men as these men you have chosen for judges, and some of us are a great deal better. You have given them an unfair advantage over us and do not get any better justice than we would dispense to you. Therefore, we ask you to abolish the office of judge, and let every man select what lawyer he pleases to decide his case."
>
> It is this *quasi* judicial capacity in which the County Surveyor, more than any other surveyor, acts which is the chief obstacle in the way of abolishing the office. When the people can be convinced that it is better to submit their boundary disputes to the nearest surveyor rather than to one chosen for that purpose by their suffrages, there will no longer be any difficulty in getting rid of the County Surveyor.
>
> The surveyors of Michigan, in 1869 and again in 1883, made united, earnest but unsuccessful efforts to abolish the office. Since then they have tacitly agreed to let the County Surveyor alone and try to improve their own positions by improving themselves and their work. As the result very many of them are getting better prices and making more money than the County Surveyor, so much so that in many counties the office is not a desirable one to hold.

Equivalents or Useful Numbers for Simplifying Calculations and for Slide Rule Practice.

BY WM. COX, C. E.

The following equivalents or useful numbers, are intended to facilitate the working out of calculations into whose composition decimals and other complex numbers enter. They will also be found of very great use in slide rule practice, as in nearly every case they are so determined that they shall fall exactly upon its *marked divisions*, so that in "setting" them no estimation of intervals on the rule or slide will be necessary. They will, therefore, materially aid in obtaining correct solutions of all problems worked out by the aid of this useful instrument.

The real value of each equivalent is given, as also the amount of error per cent., so that the degree of approximation to any given ratio may be at once seen.

The principle of giving the ratio of one quantity to *unity* in the other quantity (or reciprocals), has

not been adopted in these equivalents, because such ratios are, in many cases, more tedious to work out, and also because they are often more difficult to "set" on the slide rule, owing to the frequent necessity of estimating the exact point opposite which unity should be placed, thus leading to errors in the solutions sought.

The converse of the ratios is not given, as by the method adopted they are unnecessary; thus the ratio between U. S. gallons and cubic feet is 800 : 107, and consequently the ratio between cubic feet and U. S. gallons is 107 : 800. One setting on the slide rule serves for both.

As an example of the use of these equivalents, let us take a case of daily occurrence: The ratio between the diameter of a circle and its circumference is 1 : 3.1415926.... In ordinary practice this is taken as 1 : 3.1416, but even then multiplication or division by this number are long and tedious operations. An equivalent often adopted is that of 7 : 22, which is, however, only approximative, its value being 1 to 3.142857.... Another equivalent, and of equally easy use with the slide rule, and not much more difficult for the purposes of ordinary calculations is 226 : 710 (*i. e.*, 113 : 355) whose value is 1 : 3.1415929 , which is more correct than the ratio generally adopted of 1.: 3.1416, as it is exact to 6 places of decimals, whereas the other is only correct to 3 places.

Quantities.	Equivalents.	Exact ratio.	Error per cent.
Geometrical:			
Diameters of circles and circumference circles	225 = 710	1 = 3.14159	.00001 +
Diameters of circles and side equal square	79 = 70	1 = .8862	.017 —
Diameters of circles and side inscribed square	99 = 70	1 = .7071	.004 —
Circumference circles and side equal square	33 = 11	1 = .282	.014 —
Circumference circles and side inscribed square	40 = 9	1 = .225	.036 —
Side of square and diagonal of square	70 = 99	1 = 1.4142	.005 +
Area square, side = 1, and area circle, diameter = 1	14 = 11	1 = .7854	.04 +
Area of circle and area inscribed square	11 = 7	1 = .6366	.04 —
Arithmetical:			
Links and feet	100 = 66	1 = .66	None.
Links and inches	12 = 95	1 = 7.92	.05 —
Square links and square feet	101 = 44	1 = .4356	None.
U. S. gallons and imp. gallons	6 = 5	1 = .8 312	.025 +
U. S. gallons and cubic inches	1 = 231	1 = 231	None.
U. S. gallons and cubic feet	800 = 107	1 = .13368	.005 +
Imp. gallons and cubic inches	22 = 6100	1 = 277.27	None.
Imp. gallons and cubic feet	4 0 = 69	1 = .16046	None.
Metric System:			
Inches and centimeters	26 = 66	1 = 2.5399	.06 —
Feet and meters	82 = 25	1 = .30479	.028 +
Yards and meters	82 = 75	1 = .91438	.028 +
Miles and kilometers	31 = 50	1 = 1.6093	.22 +
Links and meters	43.0 = 865	1 = .20116	None.
Chains and meters	43 = 865	1 = 20.116	None.
Square inches and square centimeters	31 = 200	1 = 6.4513	.004 +
Square feet and square meters	140 = 13	1 = .0929	.005 —
Square yards and square meters	6 = 5	1 = .83609	.3 —
Acres and hectares	42 = 17	1 = .40467	.022 +
Square miles and square kilometers	22 = 57	1 = 2.5899	.17 +
Cubic inches and cubic centimeters	5 = 82	1 = 16.386	.08 +
Cubic feet and cubic meters	600 = 17	1 = .02831	.015 —
Cubic yards and cubic meters	85 = 65	1 = .76451	.025 +
Cubic feet and litres	6 = 170	1 = 28.315	.015 —
U. S. gallons and litres	14 = 53	1 = 3.7855	.005 +
Imp. gallons and liters	46 = 209	1 = 4.5435	.0002 —
Grains and grammes	108 = 7	1 = .0648	.0023 +
Ounces and grammes	6 = 170	1 = 28.349	.015 —
Pounds and kilogrammes	75 = 34	1 = .45359	.065 —
Hundredweights and kilogrammes	63 = 3200	1 = 50.802	.018 —
British tons and metric tonnes	63 = 64	1 = 1.016	.017 —
Pressures:			
Pounds per square inch and kilogrammes per square meter	640 = 45	1 = .07031	.0004 +
Pounds per square foot and kilogrammes per square meter	51 = 249	1 = 4.8826	.006 —
Pounds per square yard and kilogrammes per square meter	59 = 32	1 = .54251	.027 —
Inches mercury and pounds per square inch	57 = 28	1 = .49116	.012 +
Inches mercury and pounds per square foot	82 = 5800	1 = 70.727	.006 +
Inches water and pounds per square inch	720 = 26	1 = .03612	.004 —
Inches water and pounds per square foot	74 = 385	1 = 5.2021	.01 +
Feet water and pounds per square inch	60 = 26	1 = .4335	.04 —
Feet water and pounds per square foot	5 = 312	1 = 62.425	.01 —
Inches mercury and feet water	15 = 17	1 = 1.1334	.009 —
Atmospheres and inches mercury	97 = 2900	1 = 29.922	.1 —
Atmospheres and pounds per square inch	34 = 500	1 = 14.706	.007 —
Atmospheres and pounds per square foot	34 = 7200	1 =2116.8	.04 +
Atmospheres and kilogrammes per centimeter	30 = 31	1 = 1.033	None
Atmospheres and feet of water	23 = 780	1 = 33:9	None
Atmospheres and meters of water	3 = 31	1 = 10.33	None
Pounds per square inch and feet of water	29 = 67	1 = 2.311	.03 —
Kilograms per sq. centimeter and meters of water	1 = 10	1 = 10	None.
Combinations:			
Pounds per foot and kilograms per meter	43 = 64	1 = 1.4882	.007 +
Pounds per yard and kilograms per meter	127 = 63	1 = .49606	.0002 —
Pounds per cubic foot and kilograms per cubic meter	49 = 785	1 = 16.019	.006 +
Cubic feet per minute and liters per second	89 = 42	1 = .47192	.002 —
Imp. gallons per minute and liters per second	700 = 53	1 = .07572	.0013 —
U. S. gallons per minute and liters per second	840 = 53	1 = .06309	.0004 +
Weight fresh water and weight sea water	38 = 39	1 = 1.026	.006 +
Cubic feet water and weight in pounds	5 = 312	1 = 62.425	.01 —
Imp. gallons water and weight in pounds	1 = 10	1 = 10	None.
U. S. gallons water and weight in pounds	3 = 25	1 = 8.333	None.
Pounds per U. S. gallon and kilograms per liter	50 = 6	1 = .11982	.015 —
Pounds per imp. gallon and kilograms per liter	10 = 1	1 = .09983	.017 —
Pounds per U. S. gallon and pounds per imp. gallon	30 = 25	1 = .8333	None.
Cubic feet water and weight in kilograms	3 = 85	1 = 28.315	.015 —
Imp. gallons water and weight in kilograms	46 = 209	1 = 4.5435	.0002 —
U. S. gallons water and weight in kilograms	14 = 53	1 = 3.78551	.005 +
Feet per second and miles per hour	44 = 30	1 = .6818	None.
Yards per minute and miles per hour	88 = 3	1 = .03409	None.
Feet per second and meters per minute	41 = 750	1 = 18.287	.027 +
Feet per minute and meters per minute	82 = 25	1 = .3048	.025 +
Foot pounds and kilogrammeters	340 = 47	1 = .13825	.013 —
British horse power and French horse power	72 = 73	1 = 1.0138	.003 +
One cubic foot water per minute under feet of head and horse power (British)	3700 = 7	1 = .00189	.0003 +
One liter water per second under meters of head and horse power (French)	75 = 1	1 = .0133	None.

It will be seen that in the above equivalents, the greatest divergence from the exact ratios is three per thousand.

EXAMPLES.

What is the pressure in pounds per square inch equivalent to a head of 34 ft. of water?

$$\frac{26 \times 34}{60} = 14.75 \text{ lbs., answer.}$$

and on the slide rule,

C	Set 60	under 34	
D	on 26	find 14.75 lbs., answer.	

What head of water in feet is equal to a pressure of 18 lbs. per sq. in.?

$$\frac{60 \times 18}{26} = 41.5 \text{ ft., answer,}$$

and on the slide rule,

C	Set 60	find 41.5 ft. = answer.	
D	on 26	over 18	

How many theoretical horse power will 50 cu. ft. of water per minute give under a head of 400 ft.?

C	Set 3,700	runner to 400	1 to runner	under 50
D	on 7			find 37.8 HP., answer.

[We think we can guarantee the accuracy of the above ratios, and also that it is the most complete and useful table of the kind in print, in English at least.—Ed. Eng. News.]

A Correction.

In "Designs submitted for the Washington Bridge over Harlem River," published in our last issue, page 564, an error occurs in stating the dimensions of the plan submitted by Messrs. Buck & McNulty. The plan really prepared by them was for a metal arch of 543 ft. span and 90 ft. wide instead of the figures given. The error arose from an uncorrected advance proof sheet of "The History, etc.," falling into our hands.—Ed. Eng. News.

Tests of a Compound Locomotive; Union Elevated Railroad, Brooklyn, N. Y.

(*Concluded from p. 556, Dec. 27, 1890.*)

Indicator diagrams illustrating the cylinder performance under varying conditions were taken from a series of cards made on a surface road just before the engine was placed on the elevated railway. They were made during a run of 27 miles between Providence and Kingston, on the New York, Providence & Boston R. R., with a miscellaneous freight train.

A ¾-in. pipe, 11 ins. long, for each end of each cylinder was connected to the indicator by a three-way cock in such a manner as to avoid abrupt turns or small apertures; these connections were well wrapped with asbestos. The cross-head motion was reduced by a special device of the pantograph type, requiring a string connection of only a few inches in length. The pistons of the indicator were carefully watched and lubricated, and no signs of sticking are visible on the cards. The cards were all taken with a No. 80 spring. The speed was taken with a revolution counter of positive action in the cab, the motion being taken from the pantograph. The steam gauge and indicator springs were tested before the cards were taken. The valve motion was the ordinary Stephenson link as applied to locomotives generally, except that the direction of its motion was reversed, the eccentrics being on the forward axle pointing toward the rear or main axle, with short eccentric rods. This was a feature that had to be contended against in endeavoring to get equal cut-offs and openings for the valves in all the various positions. The valve dimensions were given last week.

The operation of taking a set of cards was as follows: There was a man at each indicator and a man in the cab. The latter at a desired time gave the indicator men a signal to be ready, and threw in the catch to the counter; he then gave a signal on the whistle at which the cards were taken simultaneously from each cylinder. The steam gauge and notch were noted, and at the end of 10 seconds the speed counter was detached, and a reading taken. The speed was thus taken while cards were made, and cards were taken as nearly simultaneously as possible. Steam chest lines are given in Figs. 1 and 2, where, as on other diagrams, which we

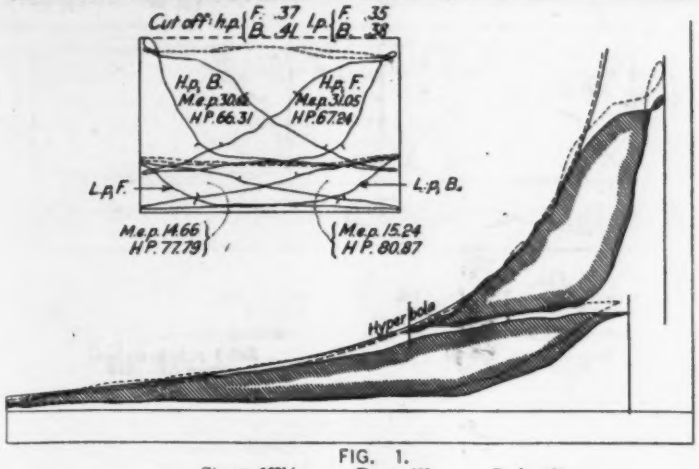


FIG. 1.

Steam, 163¼. Revs., 258. Scale, 160.
Average m. e. p. { h. p., 30.84 / l. p., 14.95 } Ref. l. p. to h. p., 36 63.
Total HP., 146.11

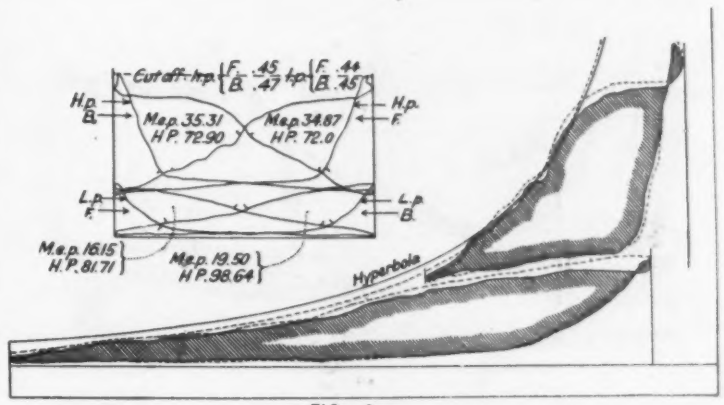


FIG. 2.

Steam, 151½. Revs., 246. Notch, 1. Scale, 160.
Average m. e. p. { h. p., 35.09 / l. p., 17.8 } Ref. l. p. to h. p., 43.68.
Total HP, 102.63.

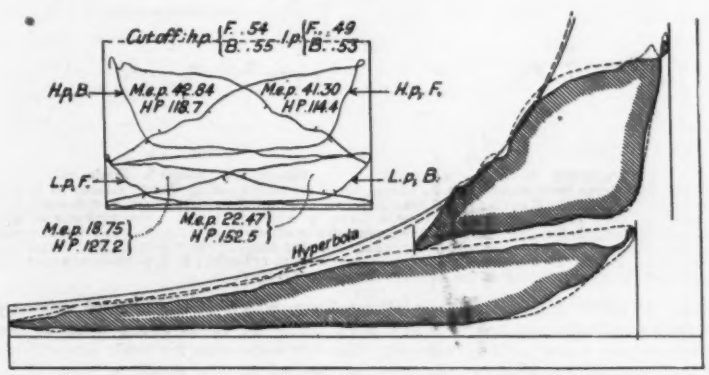


FIG. 3.

Steam, 157. Revs., 330. Notch, 2. Scale, 160
Average m. e. p. { h. p., 42.07 / l. p., 20.61 } Ref. l. p. to h. p , 50 49.
Total HP., 256.5.

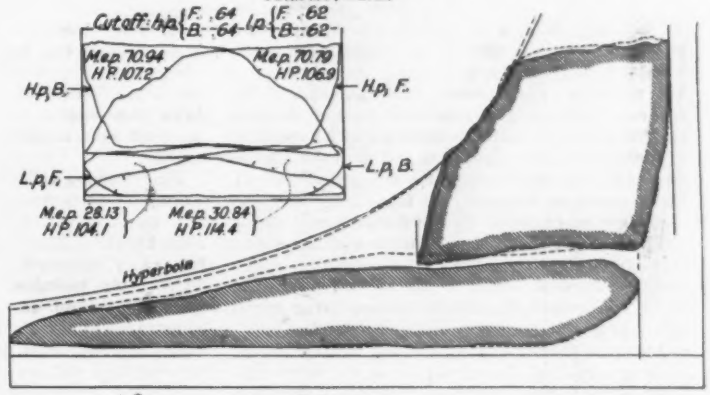


FIG. 4.

Steam, 161. Revs., 180. Notch, 3. Scale, 160.
Average m. e. p { h. p , 70.87 / l. p., 29 49 } Ref. l. p. to h. p., 72.25.
Total HP., 216.3.

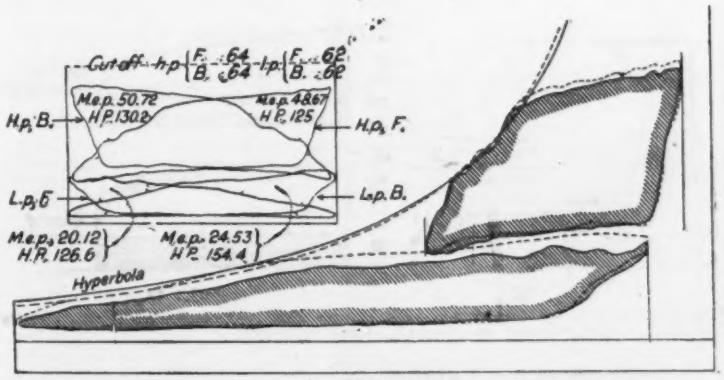


FIG. 5.

Steam, 148¼. Revs., 306. Notch, 3. Scale, 160.
Average m. e. p. { h. p., 49.70 / l. p., 22.33 } Ref. l. p. to h p., 54.71.
Total HP., 268.1.

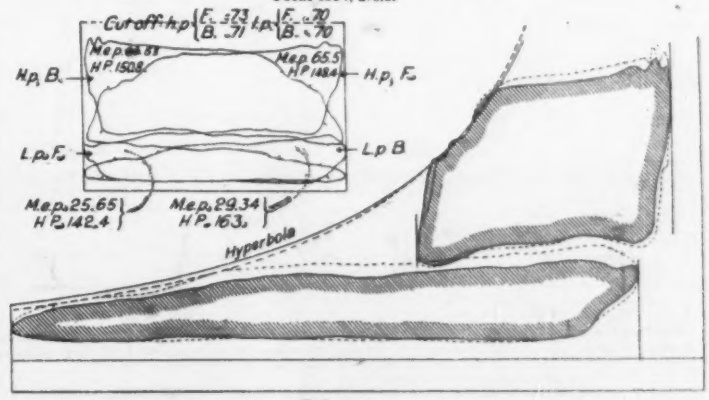


FIG. 6.

Steam, 159. Revs., 270. Notch, 4. Scale, 160.
Average m. e p. { h. p., 66.02 / l. p., 27.50 } Ref. l. p. to h. p., 67.37.
Total HP., 362.3.

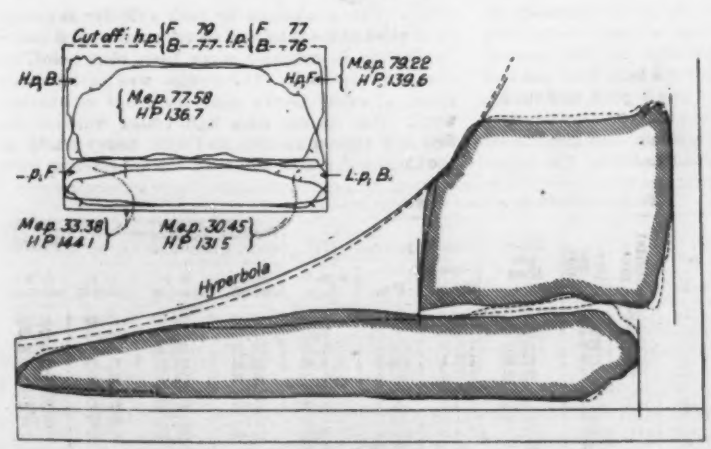


FIG. 7.

Steam, 156. Revs., 210 Notch, 5. Scale, 160.
Average m. e. p. { h. p., 78.40 / l. p., 31.92 } Ref. l. p. to h. p., 78.20.
Total HP., 276.

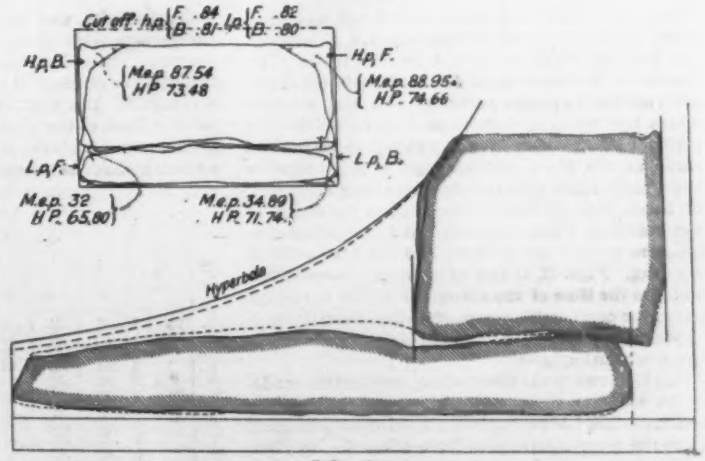


FIG. 8.

Steam, 150. Revs., 100. Notch, 9. Scale, 160.
Average m. e. p. { h. p., 88.25 / l. p., 33.45 } Ref. l. p. to h. p., 81.95.
Total HP., 142 84.

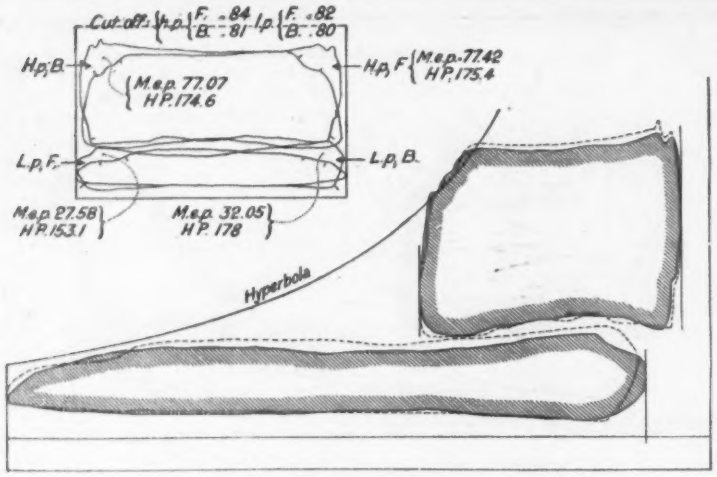


FIG. 9.

Steam, 161. Revs., 270. Notch 6. Scale, 160.
Average m. e. p. { h. p., 77.25 / l. p., 29.82 } Ref. l. p. to h. p., 73.06.
Total HP., 340.6.

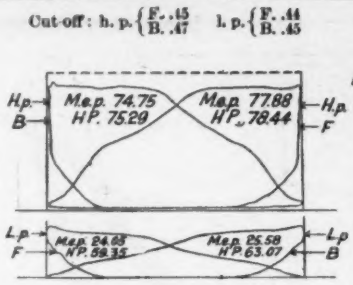


FIG. 10.

Steam, 128. Revs., 120.
Notch 1. Scale, 160.
Average m. e. p. { h. p., 76.31 / l. p., 24.82
Ref. l. p. to h. p., 60.81
Total HP., 138.08

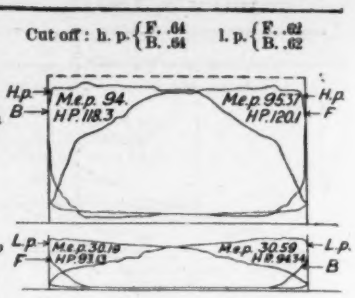


FIG. 11.

Steam, 139½. Revs., 150.
Notch 3. Scale, 160.
Average m. e. p { h. p., 94.60 / l. p., 30.39
Ref. l. p. to h. p., 74.45
Total HP., 212.9

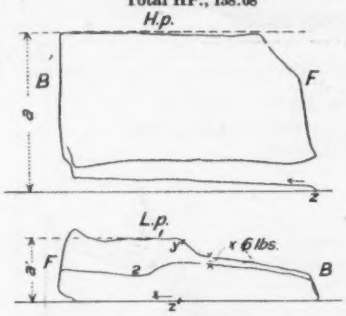


FIG. 12.

Steam, 150. Notch 7. Scale, 160.

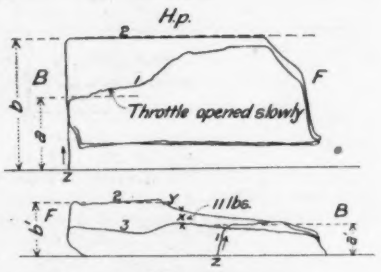


FIG. 13.

Steam, 125. Notch 7. Scale, 160.

Engine starts from rest at z (both cards), both cylinders using direct steam to y (l. p. cards), Fig. 12, one-half rev., Fig. 13 nearly 1 rev. a is initial pressure in h. p. cylinder. a' is initial pressure which l. p. cylinder should have, in order to make total pressures on both pistons equal. x is the difference between pressure in receiver at time of changing into compound, and normal pressure in receiver when running compound, reverse lever remaining the same. In Fig. 13, b is third initial pressure in h. p. cylinder; b' (l. p. card) is a pressure and that the ratio of b to b' is the same as the ratio of a to a'.

do not reproduce, a very close correspondence is shown between the cylinder and steam chest cards. Figs. 1 to 9, inclusive, have each a set of high and low pressure cards, traced with the atmospheric line common; and also a combined diagram showing the continuous expansion associated with hyperbolic expansion (full smooth curve), and with the expansion of dry saturated steam (dotted smooth curve). In the combined diagram, the front and back end cards are represented by full dotted lines. Cards shown on Figs. 10 and 11 were taken with the engine working on the simple system. The speed at which these cards were taken is far in excess of what would be required, the simple system being desirable only in starting heavy trains, or running them under exceptionally hard conditions at slow speed. In these cards the admission line to the large cylinder shows the operation of the reducing valve to limit the initial pressure to a proper proportional amount, but the boiler pressure admission pipe to the large cylinder not being large enough to satisfy these speeds, the steam was wiredrawn, which gives the difference in m. e. p. between the two cylinders, as figured on the cards. The contour of the cards from the large cylinder, however, shows the proper reduction of initial pressure which the reducing valve secures at a considerable piston speed, which was the object of taking the cards at the given speeds. Figs. 12 to 16 inclusive show cards made with the engine starting from rest; of these, Figs. 15 and 16 simply show the action of the reducing valve in keeping the total admission pressure on each piston alike and constant while it is acting. Figs. 12, 13 and 14 show the above action and also the time of the automatic action in changing to the compound system, showing the difference in pressure in the receiver at the time of the change and a revolution later.

Fig. 17 shows cards illustrating revolutions made by an ordinary compound engine after the throttle is shut, before the passages are freed from pressure, when the reverse lever is in the last notch. In yard work this is a hindrance, and is undesirable at any time, when it is necessary to stop before the engine can clear itself of steam. This can be obviated by the use of the device which allows this engine to be used as a simple engine.

The following table contains results from the cards shown in Figs. 1 to 11, tabulated for easy reference. This table includes the steam weight accounted for by the diagrams. It offers an opportunity to compare the difference in cylinder economy between high and low pressure steam under similar conditions. It also shows the water consumption to vary but little through the varying speeds under like pressures of steam at the same cut-offs. It is claimed that the table and cards embody good general results, and show to good advantage in comparison with those from ordinary locomotive practice. The loss in pressure by the passage through the receiver is small for both slow and fast revolutions. The admission line is good, and the expansion lines of the different diagrams hold closely to the curve of saturated dry steam, tending to show a small amount of initial condensation. The water per HP. per hour, which is the test of economy, figures low even on the cards doing work at fast speeds. This low water rate for work done, shown by cards, is verified by the result of the actual service test, in which nearly 24 per cent. less water was used by the compound than by the simple engine in doing practically the same work for 14 hours. The work done by each cylinder is practically alike at the third and fourth notches, and varies by degrees in opposite ways from that point, as shown by the table. The design was to have the point of equal power near the point of average work. This engine with light trains works in the first and second notches, and with heavy trains in the third and fourth notches; always starting from

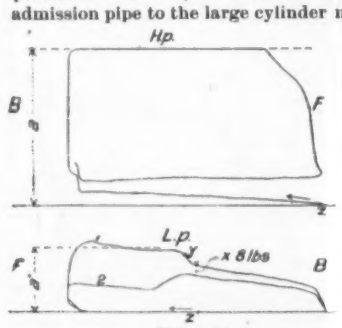


FIG. 14.

Engine starts from rest at z (both cards), both cylinders using direct steam to y (l. p. card), one-half revolution. a is initial pressure in h. p. cylinder; a' is initial pressure which l. p. cylinder should have in order to make total pressures on both pistons equal. x is the difference between pressure in receiver at time of changing into compound, and normal pressure in receiver when running compound, reverse lever remaining the same.

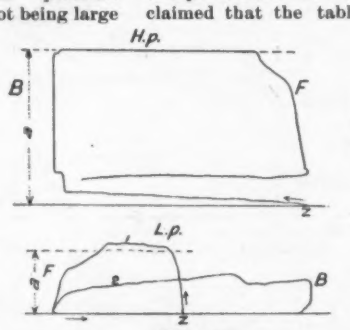


FIG. 15.

Engine starts from rest at z (both cards), both cylinders using direct steam, and changes into compound during exhaust stroke, l. p. card, not less than one-half revolution.

a is second initial pressure in h. p. cylinder; a' is first initial pressure which l. p. cylinder should have in order to make total pressures on both pistons equal, assuming first initial pressure in h. p. cylinder to be like a.

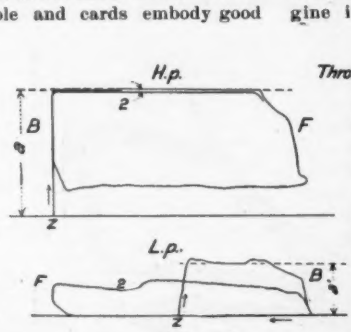


FIG. 16.

a is initial pressure in h. p. cylinder; a' is initial pressure which l. p. cylinder should have in order to make total pressures on both pistons equal.

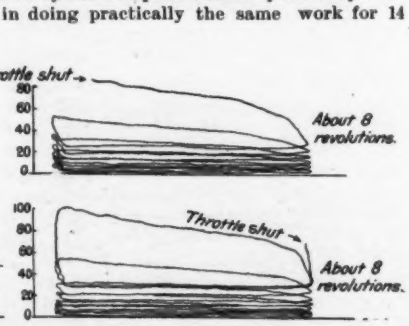


FIG. 17.

Cards from compound engine with throttle closed; last notch.

TABLE OF DETAILS FROM INDICATOR DIAGRAMS.

Fig.	Notch.	Cut-off h. p. F.	Cut-off h. p. B.	Cut-off l. p. F.	Cut-off l. p. B.	Initial press.	Revs. per min.	Miles per hour	Horse power. h. p.	Horse power. l. p.	HP. ratio l. p. to h. p.	Pounds of water per HP. per hour, accounted for by indicator. h. p. cut-off.	h. p. release.	l. p. cut-off.	l. p. release.
1..	No. 1	.37	.41	.38	.40	146	258	32.25	66.78	79.33	1.19	16.19	16.49	15.49	18.54
2..	" 1	.45	.47	.44	.45	133	246	30.75	72.45	90.18	1.24	17.28	17.77	16.81	18.24
3..	" 2	.54	.55	.49	.53	135	330	41.25	116.6	139.9	1.20	19.32	19.56	18.57	17.96
4..	" 3	.64	.64	.62	.62	149	180	22.50	107.1	109.2	1.02	19.31	19.45	17.79	18.05
5..	" 3	.64	.64	.61	.62	130	306	38.25	127.6	140.5	1.10	21.84	22.04	19.40	20.79
6..	" 4	.73	.71	.70	.70	141	270	33.75	119.6	152.7	1.02	22.51	22.44	21.28	21.86
7..	" 5	.79	.77	.77	.76	145	210	26.25	138.2	137.8	0.997	22.21	22.00	21.42	21.22
8..	" 6	.84	.81	.82	.80	136	100	12.50	74.07	68.77	0.98	22.50	22.75	20.97	21.01
9..	" 6	.84	.81	.82	.80	144	270	33.75	175.0	165.6	0.95	25.66	25.48	25.29	25.12
10..	" 1	.45	.47	.44	.45	117	120	15.00	76.87	61.21	0.80	.....	.....	.....	.....
11..	" 3	.64	.64	.62	.62	127	150	18.75	119.2	93.74	0.79	.....	.....	.....	.....

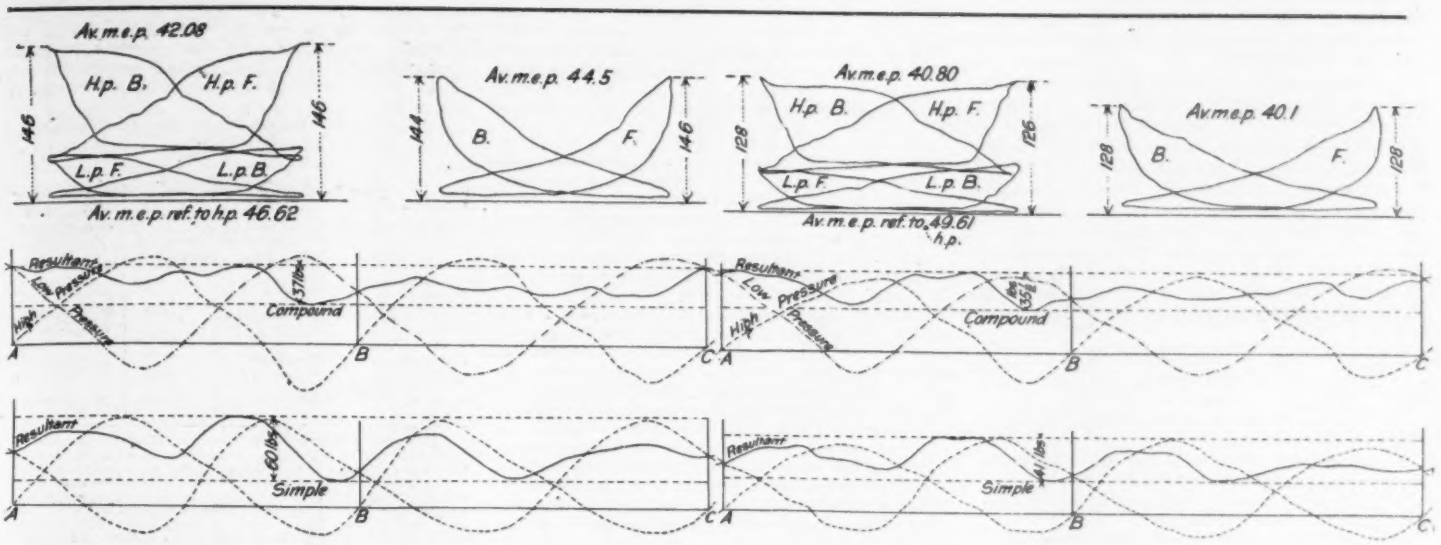


FIG. 18.

FIG. 19.

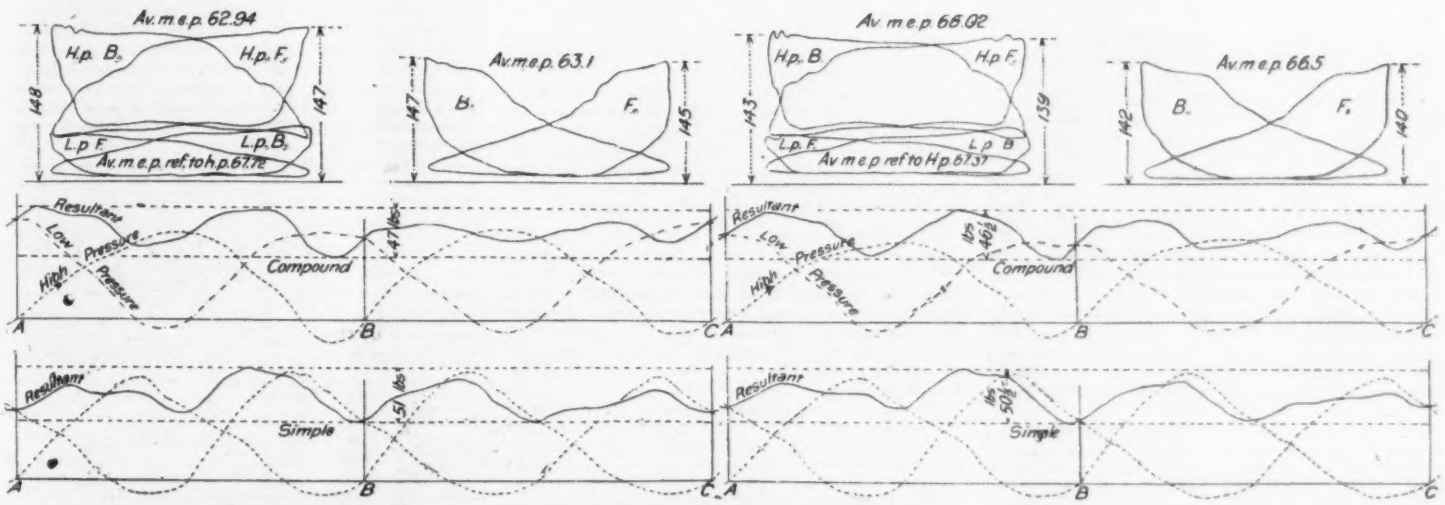


FIG. 20.

FIG. 21.

Rotative effect on simple and compound engines from actual cards of similar initial steam pressures and mean effective pressures. On each diagram the straight line A B C is the development of crank pin circle; scale 1 in. equals 1 ft. A and C are at back dead point of left crank; B is at forward dead point of left crank. Heights above A B C represent rotative effects, 1 in. in height equalling 160 lbs. per sq. in. of h. p. piston, exerted at crank pin at right angles to crank.

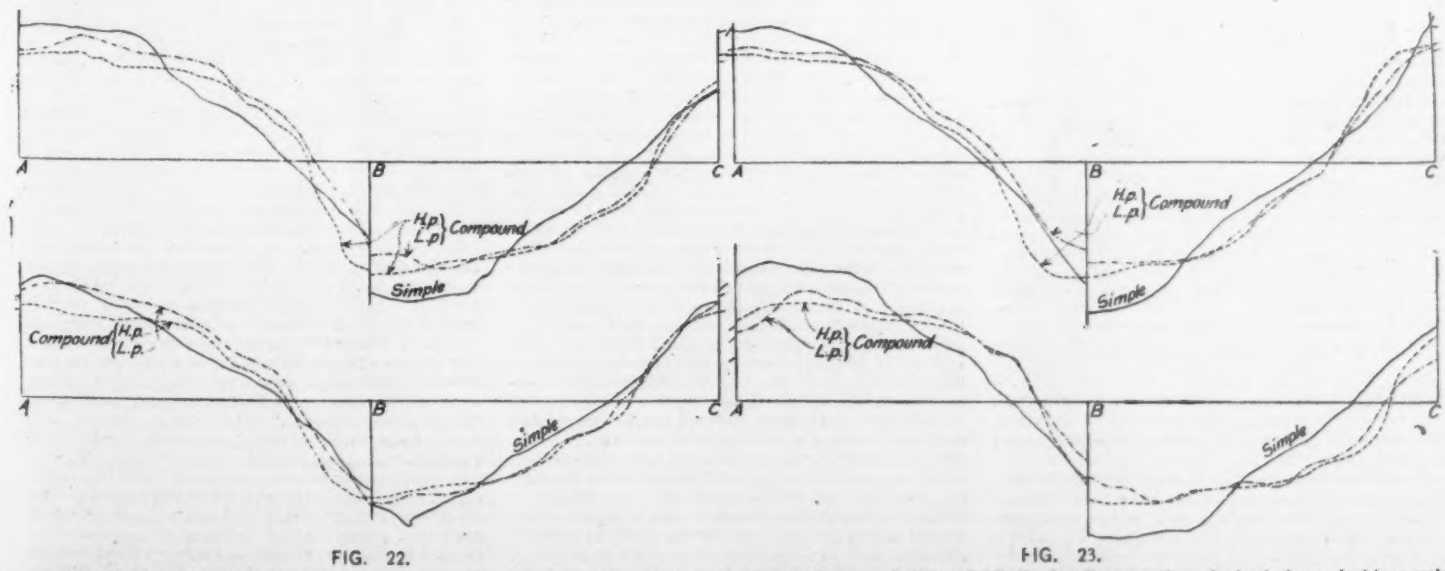


FIG. 22.

FIG. 23.

Crank pin stress on simple and compound engines, from data on Figs. 19 and 20. On each diagram the straight line A B C is the development of crank pin circle; scale, 1 in. equals 1 ft. A and C are at the back dead point; B is at the forward dead point. Vertical distances from A B C represent total force acting on crank pin, due to steam pressure; 1 in. in height equaling 160 lbs. per sq. in. of h. p. piston. Distances above A B C correspond to pulls of the connecting rod. Distances below A B C correspond to thrusts of the connecting rod.

the seventh or last notch. The low exhaust pressure shown on all cards, at the ordinary working notches, is one cause of the water economy, and also signifies the style of action on the fire, these light exhausts occurring but twice a revolution in place of four times.

Aside from the economy in fuel and water consumption, an important result of the difference in cylinder performance between a simple and compound locomotive, under similar conditions, is that the latter should bring to bear upon the moving parts a more continuous or even stress, while subjecting those parts to loads of less magnitude at the point of maximum stress. The effect of the applied power should also be more regular in the compound engine. As illustrative of this effect, graphically, Figs. 18, 19, 20 and 21 give the rotative effect on each crank pin, together with the resultant effect for one revolution. The data taken for a simple locomotive, in working up these diagrams, are actual cards selected from first-class locomotives having Richardson-Allen valves, and a good steam distribution. Those for a compound are taken from No. 58, with initial pressures and m. e. p.'s to match the cards

from the simple engine. These figures explain themselves, and suggest a steadier moving engine, more especially at high speeds, and the shortest cut-offs. This is a very de irable result, as it affects the connections throughout the train. Figs. 22 and 23 show diagrams made from the same data, illustrating graphically the stress upon the crank pins, and hence the other moving parts, for one revolution. It will be observed that the lines representing the stresses on the crank pins of the compound keep within closer vertical limits than those on the simple engine; also, that the former keeps much nearer a continuous line, sudden variations in load being inappreciable. Cylinder oil can be used with the best economy in the compound engine, the oil fed to one cylinder passing through both cylinders.

PERSONALS.

Mr. PRATT, superintendent of water-works at Seattle, Wash., has resigned.

Mr. B. SHREINER, Assistant City Engineer of Des Moines Ia., was fatally shot on Dec. 25.

Mr. TUCKER, General Manager of the Chicago, Milwaukee & St. Paul Ry., has resigned.

Mr. COLBY, Engineer of the Public Improvement Commission, of Troy, N. Y., has resigned.

MESSRS. FREEMAN & MILL have opened an office as consulting engineers at S. E. corner Second and Race Sts., Cincinnati, O.

Mr. OSCAR SAABYE, M. Am. Soc. C. E., has been appointed Division Engineer of Maintenance of Way, on the Roanoke division of the Norfolk & Western R. R.

Mr. ALBERT M. CAMPBELL, C. E. and M. E., of Charleston, W. Va., has assumed the management of the Mount Carbon Coal Co., Limited, at Powellton, W. Va.

Mr. HENRY C. FOLGER, who has been for over 5 years with the National Meter Co., has accepted the position of Secretary and General Manager of the Thomson Meter Co.

Mr. R. B. WILLIAMS, formerly of the West Shore R. R., has been appointed Superintendent of the Western Division of the New York & New England R. R. Mr. D. H. NICHOLS is General Superintendent of the road.

Sir JOSEPH HICKSON, General Manager of the Grand Trunk Ry., has resigned. He succeeded Mr. C. J. BRYDES in 1874, and will now be succeeded by Mr. L. J. SARGEANT, General Traffic Manager. He will remain in Montreal, and will act as adviser to the Canadian Board of Directors.

Mr. SELA CHAMBERLAIN died at Cleveland, O., on Dec. 27. He organized the Chicago, Milwaukee & St. Paul Ry. Co., and built most of the lines comprising its system. He also built the Lake Champlain, the Cleveland & Pittsburg and the Cleveland, Lorain & Wheeling R. R., of which latter road he was president at the time of his death. He also built several canals in Ohio, Pennsylvania and Indiana.

Col. WM. H. PAINE, Past. Pres. Am. Soc. C. E., died suddenly at Cleveland, O., Dec. 31. He was born at Chester, N. H., in 1828. In 1849 he made surveys for a wagon road across the Rocky Mountains, and in 1853 for a railway from Sacramento into Utah. During the war he served in the Engineer Corps. In 1869 he was chosen one of the engineers for the Brooklyn Bridge; he designed the grip for the cable cars, and after the completion of the bridge continued to act as engineer until July, 1889, when he resigned and opened an office in New York as a consulting engineer, making cable railways his specialty. He prepared the plans for the 10th Ave. and 125th St. cable railway in New York, and assisted in the preparation of those for the proposed Third Ave. line. He had been connected with cable roads in Denver, Kansas City and Omaha, and at the time of his death was in charge of the construction of 20 miles of line for the Cleveland City Cable Ry. Co.

NEW PUBLICATIONS.

—*The Rulo Bridge.* A report to Charles E. Perkins, President Chicago, Burlington & Quincy R. R., By GEORGE S. MORISON, Chief Engineer of the Rulo Bridge. Large folio; pp., 30; 23 plates.

This Rulo bridge crosses the Missouri River at the town of that name and near the mouth of the Great Nemaha branch. It is a single track railway bridge, with three channel spans of 375 ft. each, with two approaches of three 125 ft. deck spans each. The piers are of granite on pneumatic caissons for the channel spans, and of cylindrical form for the approach spans. The text includes a general description of sub and superstructure, and valuable tabular detail of cost of foundations and time of execution. The weights and cost of the superstructure is also given in a similar manner. The appendix contains the masonry specifications; record of caisson sinking; detail of time cost and material used in foundations for separate piers; specifications for superstructure and tests of steel eye bars. The illustrations are very complete, as would be expected from a work brought out under the supervision of Mr. MORISON. One of the most interesting of these is the "clay hoist," or special air-lock with an elevator arrangement for lifting and dumping buckets of clay. The movement is that of the ordinary elevator, with compressed air substituted for hydraulic power. The diagram showing rate of progress in caisson sinking is also novel in its arrangement.

—*The Basic Bessemer Process.* Translated from the German of Dr. HERMAN WEDDING by Prof. WM. B. PHILLIPS, Univ., Ala., and ERNST PROCHASKA, Metallurgical Engineer. New York Scientific Publishing Co., 8vo; pp. 224; 70 cuts, 5 large plates. $3.50.

This work is beyond question the most complete, as it is almost the only one, on basic Bessemer processes. Its author, Dr. WEDDING, is (or was till lately) Professor of Metallurgy in the Royal Mining Academy of Berlin. He is one of the most eminent living authorities on metallurgical subjects, and he has gone into this basic process with true German thoroughness. A second edition of the original work appeared only last year (the original having been first published in 1884), but added little of value to what was given in the 1884 addition, the translators declare. We presume, however, that what new matter was important has been included. The historical record of the process is certainly very complete, and the construction of the converter, the materials, the chemical and physical reactions of the process, are all described and illustrated with great minuteness. As is well known, this process has been much more extensively applied in Germany than elsewhere, and it is natural that the most complete treatise on it should come from there. But there is a great field for the process in the Southern States of this country; a field which is beginning to be occupied, and there especially this translation of an admirable treatise will no doubt be highly appreciated.

We trust it is by accident that the full name of the author does not appear anywhere in the volume. Its title reads "Wedding's Basic Bessemer Process," only, instead of the more correct form which we have prefixed to our notice; and who or what the author is, except that he is "distinguished," nowhere appears. The translation was said to be an authorized one, however.

—*Les Grands Tunnels des Alpes et du Jura.* Par JAMES LADAME, ancien eleve de l'ecole polytechnique et de l'ecole des mines de Paris; ex-Directeur des mines et usines; ancien ingenieur en chef des chemins de fer du Nord de l'Espagne, du Portugal, du Clermont-Tulle et du Jura Industriel; ancien Conseiller d'etat et Directeur des travaux publics du Canton de Neuchatel. 1889. 8vo pp., 288; 4 maps. For sale by the author at 169 Boulevard Saint-Michel, Paris. Price $1.

The sub-title to this volume indicates that it is the result of an extended study of the proposed Gemmi-Simplon tunnel project, though but a comparatively small part of the book directly discusses this subject. The first 255 pages are devoted to a general history of tunneling in Europe, including a great number of the smaller tunnels, as well as those included in the title proper. The author, while referring several times to Mr. DRINKER'S excellent work, handles his subject differently. M. LADAME does not deal with tunnel methods or detail of working. He simply gives in a very concise form the results of an extended European experience in the cost of tunneling, and the reader must bear in mind that all prices used are based upon this European practice and upon generally low wages for labor. With this caution, many of the results are interesting and valuable to tunnel engineers.

Commencing, practically, with a description of the Jura tunnels of Credo, Loges and Hauenstein (built 1854-60), he gives in each case their rate of progress, cost and general method of working. The great tunnels of the Alps are next described separately, as to history, plant used, method of attack, character of material, cost at various periods, etc. This portion of the work covers the Mont-Cenis, Saint Gothard and the Arlberg tunnels. Succeeding chapters are devoted to a similar description of the exceptional tunnels of France and Spain; and a list is given of tunnels of the second class in France, arranged in tabular form and classified under the various materials penetrated. In this list the presence of water, etc., depth and number of shafts, cost per running metre of excavation, timbering, masonry and back filling, time of construction, etc., are stated in many cases. According to a summary given there were, on Jan. 1, 1883, 304 tunnels of all classes in France, of a total length of 306,448 m., or nearly 200 miles. The total expense of construction is stated as $76,783,000, or an average cost of about $76 per lin. ft. These figures are taken from the *Documents Statistiques* published by the Ministry of Public Works in 1884. At the end of 1882 there were only 315 tunnels in France, of a total length of 91¼ miles, built at an average cost of $86.52 per lin. ft. Another table gives similar information for 43 tunnels on the Saint Gothard line, between Immensee and Lugano. In this latter list the mean cost per lineal foot was $51.52, for single track tunnel, and $85.12 for tunnels partly single and partly double track. Nine single track tunnels on the Arlberg approaches, aggregating 3,836 ft. in length, cost about the same as the minimum price for similar tunnels on the Saint Gothard line.

An interesting chapter follows on the general rules to be observed in fixing the form and dimensions of great tunnels and in estimating their cost. We cannot follow out this discussion here, but give a table of the average cost of excavation in various soils and rocks as arranged by the author from the experience gathered in the 379 double track tunnels generally treated of in this work. We translate this table into English measure, as follows:

AVERAGE COST OF EXCAVATION FOR DOUBLE-TRACK TUNNELS.

Nature of soil.	No. of tunnels.	Average price.		Minimum and maximum price per running foot. $
		Excavation per cu. yd. $	Per lin. ft. of tunnel complete. $	
Granite, gneiss	56	3.07 @ 3.85	100.00	61.46@190.40
Schist	39	1.38 @15.38	75.42	43.11@ 70.68
Trias	3	.....	90.85	84.75@ 93.33
Jurassic	60	1.23 @ 1.38	77.86	38.24@157.20
Cretaceous	34	0.61 @ 0.77	59.60	27.37@ 92.25
Tertiary and modern	39	0.31 @ 0.61	105.80	51.52@188.35

NOTE.—It may be well to describe some of the above soils as follows: Granite and schistose rocks need no further description. The Triassic rocks of Central Europe are, generally speaking, a combination of shales and limestone. The Jurassic formation consists of the harder sandstones and limestones, interstratified with softer clays and shales. The cretaceous rocks include the chalks, chalk marl and stiff blue clay. The tertiary formation includes the modern sedimentary deposits, varying widely in their composition and character, and covering clays, sand, lignite, shells, etc.

The prices given above are for the cubic yards of excavation for double-track tunnels of relatively short length. These figures include only this excavation, loading and transport of material and lighting. They do not include the timbering, which in "soft ground" often increases the expense enormously. M. LADAME follows with a table of cost of excavation only of the three great Alpine tunnels, as follows:

Tunnel.	Per cubic yard.			Per lineal foot of tunnel.
	Advance heading.	Taking out bottom.	Total section.	
Mont-Cenis.				
Hand driving	$5.88	.....	.....	.....
Machine driving	14.54	.....	.....	.....
Prolonging tunnel	6.92	$2.46	$3.07	$67.07
Saint Gothard.				
Main tunnel	17.84	8.16	9.54	170.73
Helicoidal tunnel of Wattengen	4.97	2.22	2.52	57.38
Helicoidal tunnel of Leggistein	5.70	2.31	2.75	62.74
43 tunnels on approaches	.....	.....	2.34	.....
Arlberg.				
First kilometre	15.85	3.20	4.62	114.43
Middle kilometre	16.62	3.50	5.00	123.78

The prices given above, both for heading and entire section of tunnel, include all expenses due to mechanical installation, length of tunnel, ventilation, drainage, etc. The Mont Cenis heading cubed 3.10 cu. yds. per lin. ft. The Saint Gothard heading cost about $5.00 per cu. yd., without cost of transport or extra expenses. M. PERNOLET, another engineer, figured that this heading cost $6.50 per cu. yd., and divides this as follows: Cube of heading, 2.67 cu. yds. per lin. ft., costing $17.37. This he makes up as below:

Hand labor in tunnel and removing débris	$4.54
Dynamite	9.37
Compressing air	1.33
Drill repairs, etc	2.13
Cost per lin. ft. of heading	$17.37

The consumption of dynamite was 6.2 lbs. per cu. yd. The workmen were paid 3 fr. 75 per day, or $0.75.

M. LADAME discusses at some length the influence of the length of tunnel and rapidity of progress upon the cost of construction. Up to 1,000 m., or 3,280 ft., he thinks that the relative expense varies but little in similar ground; for in such cases the attack is generally made from only two faces. Above 1,000 m., and when the overlaying soil does not exceed 600 to 900 ft. in depth, shafts must be considered. While shafts reduce the time, and the interest on invested capital, says M. LADAME, they augment by "at least $30 per lineal ft." the cost of the tunnel. This sum includes the cost of sinking the shaft, special hoisting machinery and the added expense of removing material, which latter he says is generally "about 50 cts. per cu. yd. more" than when removed in a horizontal gallery. He gives a table of 14 double and single track tunnels to prove these points. As to the influence of length of tunnel on price, he says that the Italian engineers found that the augmentation due to this fact alone was about $4.30 per lineal foot of tunnel in each kilometre, or 0.62 mile, beyond the first kilometre from the working face. This addition represented, essentially, the increased cost of transport and ventilation. In the Arlberg tunnel, the Austrian engineers figured this increase at $6.70 per lin. ft. of tunnel, on the same basis as before.

According to the experience gained at the Mont-Cenis, Saint Gothard and Arlberg tunnels, the author figures, as a general rule, that the cost of mechanical plant of a

long tunnel may be figured as follows, with European prices:

For a tunnel 6 miles long	$700,000
" " " 9 " "	800,000
" " " 12 " "	900,000

These figures do not include interest during the construction.

The concluding chapters discuss the proposed Gemmi and Simplon tunnel route at length. This route would extend from Thun to Inden in the Valley of the Rhone; then by an existing line to Brieg, and at this point tunnel under the Simplon and immerge at Domo d'Ossola. The tunnel under the Gemmi would be about one mile long and that under the Simplon 13 miles long. The total route, from Thun to Domo d'Ossola, would be 57.7 miles, and M. LADAME estimates the total cost at $30,000,000.

—*Massachusetts Institute of Technology.* Abstract of the Proceedings of the Society of Arts, for 28th year, 1889-90. Published by the Institute, 1890. Linus Faunce, Secretary. While every one of the 13 papers abstracted in this volume is interesting to engineers, the following may be especially pointed out: "Biological Analysis of Water," by Prof. W. T. SEDGWICK; "Electrical Purification of Sewage," by Mr. F. M. GILLEY; "The Application of Storage Batteries to Street Car Propulsion," by Col. E. H. HEWINS, and the illustrated description of the engineering building of the institute by Profs. CHANDLER, LANZA and SWAIN and Mr. S. H. WOODBRIDGE. "Domestic Steel for Naval Purposes" is the title of a paper by Lt.-Com. J. G. EATON, U. S. N., containing much valuable information in a condensed form. Prof. ELIHU THOMSON'S "Experiments with Alternating Currents" is also a most useful study of the effects of such currents in electric lighting and of the phenomena resulting from induction and self-induction.

—*The Flow of Water in Fire Hose.* An address by JOHN R. FREEMAN, Hydraulic Engineer, at the Mass. State Firemen's Convention, Sept. 11-13, 1890. 8vo. pp.

This paper is largely an abstract, or rather expansion into popular form, of some valuable experiments presented last year in a paper before the American Society of Civil Engineers, with other matter added gathered from the experience of the author as engineer of the department of Inspections, Adjustments, and Surveys of the Associated Factory Mutual Insurance Co. One of the most striking new facts contained in it we have noted and commented upon editorially, but the paper is otherwise full of information and practical suggestions.

—*Formulas and Tables Used in the Application of the Method of Least Squares.* MALVERD A. HOWE. Cloth, 12 mo, pp. 32. Terre Haute, Moore & Langen. A collection of the principal formulas of the theory of least squares and a number of very useful tables for calculations of probable errors are contained in this handy little volume The presswork is unusually fine.

—*Valve Gears.* By H. W. SPANGLER, P. A., Engr. U. S. N. Prof. Mech. Eng. Univ., Pa. New York: John Wiley & Sons. 8vo, pp. 175. 106 cuts. $2.50.

This volume seems to be an excellently prepared elementary text-book on the theoretical side of valve gear design, not pretending to have much that is new in it, but carefully compiled from the later sources of information. We call it elementary, not because the mathematical part of it is not complete enough to fairly cover the whole field, but because the practical side of the problem, the comparative results obtainable from different forms of different valve gears under different conditions, is not touched upon at all.

—*First Lessons in Metal Working.* By ALFRED G. COMPTON, Prof. Appl. Mech., Coll. City of N. Y., instructor in charge of workshops. New York, John Wiley & Sons; 12mo, pp. 170, 95 cuts., $1.50.

This little manual is just what its title implies, a practical elementary treatise on practical handicraft metal working, blacksmithing, welding, tempering, chilling, drilling, sawing, filing, soldering, etc. The refinements of these ancient arts are not gone into, but the methods of plain ordinary work are clearly and simply explained by the aid of numerous cuts. The book is well calculated to serve a useful purpose, for so much of the art of metal working as is explained in it ought to be well and fully practically understood by every engineer.

—*Ninth Annual Report of the United States Geological Survey.* 1887-1888. By J. W. POWELL. Director. Pub. Doc., 4to., pp. 717; 88 plates, 61 cuts.

The greater portion of this ponderous and elaborately illustrated volume is occupied by detail reports on the Charleston earthquake, the geology of Cape Ann, Mass., the Yellowstone Hot Springs, and the geology of Northwestern Colorado; all very completely and well described; but if the entire United States is to be covered with equal thoroughness, it is startling to think how many volumes the complete survey will need to cover it. The record of progress is hardly worth quoting, now that it is nearly three years old, but at the date of the report about a tenth of the entire area of the United States (306,140 sq. miles) had been accurately surveyed and contoured, and geological atlas sheets had been prepared for nearly this whole area, mostly on scales of about 2 miles per inch (1 : 125,000). It is plain that within the next twenty years or so the entire area of the United States is likely to be as accurately mapped as are most European countries; and its geological features much more accurately described and illustrated in official reports.

—*Report of the State Board of Health of California,* GERHARD G. TYRELL, M. D., Sacramento, Secretary. Pamph., pp. 284.

Appended to this report, which seems complete and valuable, are several papers of unusual interest. Among those on diseases the most striking are two on "leprosy," one of which is illustrated from photographs of several patients afflicted with the disease. A paper by W. R. CLUNESS, M.D., reviews recent sanitary progress in California, as embodied in legislation, and states present needs. Among the needs Mr. CLUNESS mentions a sanitary survey of the State, advocates the utilization of sewage for irrigation, discusses cremation of garbage and the flushing of sewers. In a country where irrigation is a necessity the utilization of sewage for this purpose seems practicable, but testimony to the contrary is given in a short article by D. G. MACGOWAN, Health Officer of Los Angeles, in which he gives an instance of a return to pure water where sewage had been used for irrigating Chinese truck gardens. In this case it is claimed that after prolonged use the land became saturated with sewage, and was less productive than formerly.

The most valuable paper in the collection, at least of those dealing with sanitation, is one on the "Disposal of Sewage," by RUDOLPH HERING, C. E., of New York City. In this paper sanitary requirements are first discussed, and then historical data and the results of experiments are presented. The paper has been printed separately in a pamphlet of 8 pages.

TRADE PUBLICATIONS.

—*Illinois Steel Co:* Milwaukee Works.—A neat catalogue of sizes and sections rolled; iron, steel and nail classifications; tables of weights and special information; lithographs of special shapes, including light rails, car truck channels, Z bars, etc.

—*Frogs, Switches and Crossings.* Catalogue of the Wier Frog Co., Cincinnati, O. Oblong 12mo., pp. 164, 85 cuts and plates.

A very handsomely prepared and complete catalogue of the specialties carried by it.

—*Table of Weights of Wrought Iron Plates.* Rochester, Bridge & Iron Works, Rochester, N. Y., Blue print pamph., pp. 10.

These tables cover plates 1 ft. long, from 1 to 80¾ ins. wide, and from 1-16 in. to 1 in. thick, inclusive, computed on the assumption that the metal weighs 480 lbs. per cu. ft. While not strictly speaking a publication, we have no doubt that copies can be obtained as a courtesy by those having good reason to ask for them, and they should prove very convenient in estimating.

SOCIETY PROCEEDINGS.

Liverpool Engineering Society.—Meeting of Dec. 10. The President, Mr. Ferdinand Hudleston, Assoc. M. Inst. C. E., in the chair. After the usual routine business Mr. Thomas L. Miller, Assoc. M. Inst. C. E., described some refrigerating apparatus which had been adopted under peculiar circumstances for the preservation of provisions at gold mines in Peru. The construction of the apparatus and the manner in which it was worked evoked considerable discussion among the members present. Mr. Miller also brought before the meeting a proposed system for the measurement of the elongation of test samples, and gave statistics of a number of tests which had been made in connection with this proposed system.

Engineers' Club of Philadelphia.—Record of regular meeting, Dec. 20, 1890. President H. W. Spangler in the chair; 21 members present. Mr. Edward Hurst Brown presented a paper on Suburban Development in which he referred particularly to the development of suburban places of residence in the vicinity of Philadelphia. Mr. Henry G. Morris advanced the opinion that a large building, something after the order of the Drexel Building in Philadelphia, could be most advantageously used as a place of residence by families; that a city could be constructed with such places on alternate squares, arranged after the manner of the black squares on a checker board, leaving the other spaces open for healthful breathing spaces and various purposes.

The Secretary presented, for Mr. John Graham, Jr., a paper upon the Use of a Pumping Dredge by the Norfolk Company at Norfork, Virginia, and explained its use in the reclamation of low waste land in such localities. He says that the advantages of this machine seem to be its ability to transport material to a reasonable distance; celerity in dredging and removing obstacles to navigation; celerity in filling; economy in removing and depositing the material. The Secretary presented, for Mr. G. R Henderson, a paper on Crown Bar Stays, illustrated by two drawings of stays, and giving the formulas by which they were proportioned in his practice, also the results of actual tests as to strength. The Secretary presented, for Mr. Charles H. Haswell, a brief paper upon Shingle for Concrete and Beton. He is of the opinion that shingle under certain conditions is superior to broken stone in the composition of concrete and beton, both in strength and in economy of cost. HOWARD MURPHY, Secretary.

Western Railway Club—At the meeting on Dec. 16 the paper by C. A. Schroyer on "Draft Rigging" (see ENGINEERING NEWS, Dec. 6) was discussed by Messrs. Waitt, Burr, Schroyer, Rhodes, Verbryck, Johann, Forsyth and others.

Mr. Waitt advocated the Lake Shore draft rigging, designed by Mr. John Kirby, in which a timber is put in joining the rigging on the two ends of the car and thus making it continuous. With this rigging breakages did not occur unless the draft sills were broken down in a wreck. He thought a mistake had been made by the Master Car Builders' Association in perpetuating the spindle drawbar. Mr. Schroyer commended the Lake Shore rigging, but said it would require such a radical change in construction that it would be difficult to adopt it.

Mr. Rhodes alluded to the statement in Mr. Scroyer's paper that buffing and pulling strains are taken on a line 4 to 6 ins. below the sill line of the car, and said that he favored attaching the draft rigging directly to the sills, and not to separate draft timbers as commonly practiced. The end sill is made narrow and deep, and is re enforced by a sub-sill attached securely to the main sill and continuous with it. There is no tearing down of the end sill in this case, and the blows received in service are largely absorbed in the sub-sill and main sill. Recently designed cars on the Chicago, Burlington & Quincy are built in this manner, and it seems as if the cost of repairs might be reduced to 15% from the 50% claimed in Mr. Schroyer's paper. The car floors have been lowered 6 ins. to 7 ins., but there have been no complaints because of the change; in fact it may be regarded as beneficial. Messrs. Verbryck and Johann related experience showing the merit of the plan proposed by Mr. Rhodes, but Mr. Schroyer opposed it, claiming that in case the draft rigging was torn out, the cost of repairs would be about four times as much when attached to the sills as when attached to separate draft timbers.

Mr. Forsyth criticised Mr. Schroyer's statement that the ideal draft rigging should absorb in itself the buffing blows, and showed how small was the capacity of a spring to take up shock. The discussion here closed.

A paper was read by Mr. D. L. Barnes on "Vertical Plane Couplers and Automatic Air brakes." The first portion of the paper with diagrams I abstracted in another column. The author claimed the vertical plane coupler to be the best device yet produced for coupling trains. To ensure its success, however, the standard of excellence must be kept up and the contour lines adopted by the M. C. B. Association must be rigidly adhered to. Under the head "Estimate of Cost in Service," the author took the ground that the average life should be based on wear as well as upon breakages. In passenger car service, for instance, the average life as regards breakages would be about 40 years: but knuckles are worn out in 3 to 6 months. In freight service, if the average life is based on the number of breakages on some roads, the life would be 25 to 35 years, whereas the coupler would certainly be worn out in much less time. The author estimated the average life of malleable iron coupler heads at 5 to 6 years on freight cars making 15,000 to 18,000 miles per year. Steel heads may last much longer, but knuckles will not last as long. However, the cost of the coupler even with this life, will not be greater than the railroads can bear, nor is it unreasonable when one considers the service performed by the device. When the breakages caused by the use of a link with the M. C. B. drawhead are removed the remaining breakages will be a small matter.

To show, however, that on some loads breakages at present are larger than has been formerly stated, the author presented statistics showing breakages of 1,000 couplers put in service at one time. At the end of 5 months, during which time the cars were off the home line 80% of the time, the total breakages were 5% of the whole number. Half these breakages, however, were due to the breaking of knuckles through pin holes The total cost of repairing the breakages was $241, or at the rate of $1.15 per car per year on the home line.

The author also favored the adoption of standard unlocking devices and the discarding of the many defective devices now on the market.

Concerning automatic air brakes the author held that the established standards necessary to successful air-brake operation must be rigidly adhered to. Other triple valves than the one in common use should only be put in service unless they are so made as to meet these standard requirements, unless they are of such design as to act equally well under the unfavorable influence of dirt and grit, and unless they are of the highest grade of workmanship throughout.

Concerning the interdependence of the brake and coupler, the author held that the brake should be put in service as fast as possible without regard to the coupler. While the vertical plane coupler is a desirable adjunct of the brake, it is far from being a necessary one. In proof of this position a letter from the Westinghouse Brake Co. was quoted.

ENGINEERING NEWS

AND

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Advertising rates. 20 cents per line *agate measure. Schedule sent on request.* **Changes** *of advertisements must be in hand on Tuesday afternoon:* **New** *advertisements Wednesday afternoon:* **Transient** *advertisements not later than Thursday noon. The last pages go to press early on Friday, and we shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.*

COMING TECHNICAL MEETINGS.

Engineers' Club of Philadelphia.—Next meeting, Jan. 3. Secy., Howard Murphy, 1122 Girard St.

Civil Engineers' Society of St. Paul.—Next meeting, Jan. 5. Secy., G. L. Wilson.

Denver Society of Civil Engineers.—Next meeting, Jan. 6. Secy., Geo. H. Angell.

Western Society of Engineers.—Next meeting, Jan. 6. Secy., J. W. Weston, 230 La Salle St., Chicago.

Engineers' Club of St. Louis.—Next meeting, Jan. 7. Secy., W. H. Bryan, 30 South 7th St.

American Society of Civil Engineers.—Next meeting, Jan. 7. Secy., John Bogart, 127 E. 23d St., New York.

Engineering Association of the Southwest.—Next meeting, Jan. 8. Secy., Olin H. Landreth, Vanderbilt University, Nashville, Tenn.

Technical Society of the Pacific Coast.—Next meeting Jan. 9. Secy., O. von Geldern, 408 California St., San Francisco.

Civil Engineers' Club of Cleveland.—Next meeting, Jan. 13. Secy., A. H. Porter, 50 Euclid Ave.

New England Railroad Club.—Next meeting, Jan. 14. Secy., F. M. Curtis.

Civil Engineers' Association of Kansas.—Next meeting, Jan. 14. Secy., J. C. Herring, Wichita, Kan.

Southern and Southwestern Railway Club.—Next meeting Jan. 15, at Atlanta, Ga. Secy., W. H. Marshall, Rookery, Chicago.

New York Railway Club.—Next meeting, Jan. 15. Rooms, Astor House. Secy., H. G. Prout.

Engineers' Club of Cincinnati.—Next meeting, Jan. 15. Secy., J. F. Wilson.

Northwest Railroad Club.—Next meeting, Jan. 16. Secy., H. P. Robinson, St. Paul, Minn.

Northwestern Track and Bridge Association.—Next meeting, Jan. 16. Secy., D. W. Meeker, St. Paul, Minn.

Western Railway Club.—Next meeting, Jan. 20. Rooms, Phenix Building, Chicago. Secy., W. D. Crosman, 816 Rookery Bldg.

Engineers' Society of Western Pennsylvania.—Next meeting, Jan. 20. Secy., S. M. Wickersham, Pittsburg, Pa.

Boston Society of Civil Engineers. Next meeting, Jan. 21. Secy., S. E. Tinkham.

Michigan Engineering Society. — Annual convention, Jan. 20 to 23, at Lansing. Secy., F. Hodgman, Climax.

With the opening of the new year, which we trust may be a happy one for all our readers, we are making preparations to further improve this journal in several ways, as notably in respect to furnishing more engravings, in the hope and expectation of making it some day as good a journal as the character of its field demands. As one step to this end and the only one we are now prepared to specify, we shall shortly issue a General Index to Engineering News, from Vol. I. to and including Vol. XXIV. (the volume just closed). This index has been so carefully prepared and cross-referenced as to make readily accessible every technical article and paragraph which has been published in the whole period between 1874 (when this journal began) and 1890, inclusive; and hence the date and the main facts, at least, of every important engineering event or design during this period can be at once found, while most of such events and designs will be found to be fully described and illustrated.

The need for such an index has been greatly felt in this office or we should hardly have felt justified in going to the trouble and expense of compiling and publishing it, but every subscriber who binds his volumes will find it useful. The work is too costly to distribute *gratis*, especially as many subscribers do not bind their files. It will be published in a separate small volume, neatly bound in cloth, and sold at one dollar, postpaid. We shall expect to issue revised editions, extended to date, every four or five years.

A hint as to the comparative strength and durability of the new and old styles of car couplers is contained in the following letter from a subscriber, who chanced to be on the spot, and thus became personally cognizant of the facts in the case:

> At 6 A. M. this morning (Dec. 24), the southbound freight on the R. & D. (Spartanburg & Union R. R.), ran on to a blind siding that had not been locked, and was thrown wrong in the night by some unknown party. Five cars of mixed freight were smashed to kindling, the engine was damaged, and a brakesman badly hurt. All the M. C. B. couplers on the cars were uninjured, as far as I could tell, and the others broken.

We are gratified to observe that it is becoming increasingly common for some reader of this journal to be near at hand when accidents with a moral to them occur, and to take pains to gather the facts for us; and we take this occasion, the opening of a new year and volume, to again request every subscriber or reader who may be in a position to obtain early and correct information of any accident which has technical interest or significance (we care for no others), to obtain drawings, photographs, and details for us as promptly as possible, and at our expense, whether we are able to finally use the information gathered or not.

We hold such failures to be the most instructive of all possible records, and the most effective in enforcing good practice; and the weaknesses of our poor human nature are such that the effectiveness of such instances varies in more than direct ratio with the seriousness of the disaster. An accident or failure which is barely escaped ought to carry with it as impressive a moral as if it had occurred, but it does not; nor will the same occurrence which causes the loss of one life have as great effect as if, through some chance having no real relation to the primary cause, a hundred had been lost. Therefore, and not because of its sensational aspect, the more serious the disaster, the more promptly and fully we desire to record the facts in regard to it.

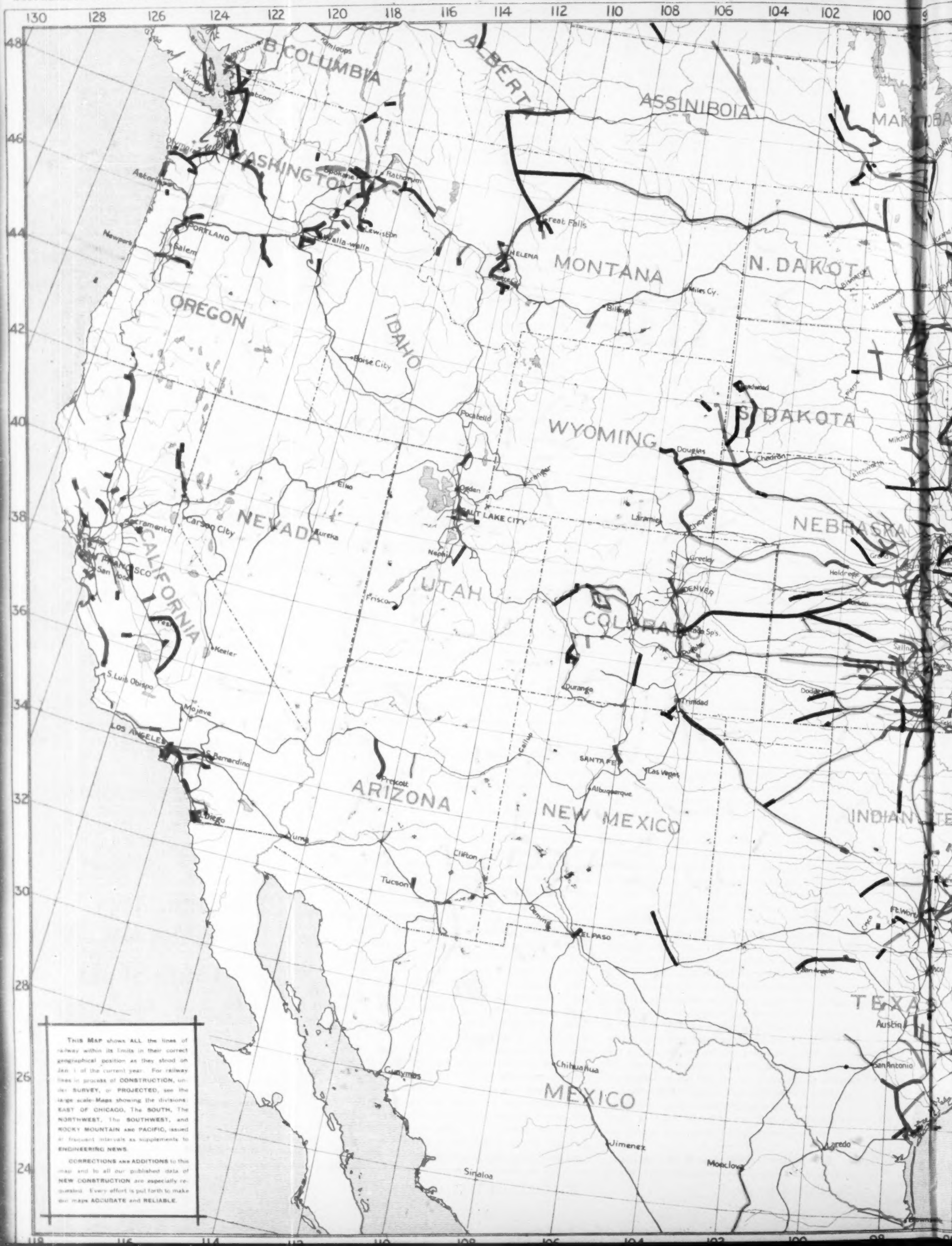
That there is even yet considerable room for useful effort in the way of the introduction of standards is strikingly illustrated by a passage from a recent paper by Mr. John R. Freeman, noticed elsewhere, urging the introduction of a standard hose coupling thread for fire hose. In regard to the need for it Mr. Freeman makes this amazing statement:

> There are at present in use in the United States more than 200 different varieties of screw threads for coupling the ordinary 2½ in. hose. The Chapman Valve Co., has more than 200 different sizers, and the Boston Woven Hose Co., has upward of 300 different sizers or pattern threads, each of which is supposed to be enough different from the others, that it would not couple and make a first-class workman like job. There are other makers of hose-fittings who have even larger stocks of sizers than these. This wonderful diversity is almost beyond belief to a man who is not engaged in the manufacture of hose, valves, hydrants, hose-couplings, fire-engines, or nozzles; but a little reflection will show to any man who is a practical machinist that it can be true. The pitches of the thread vary between 6 to an inch to 7, 7½, and 8. For each one of these different pitches nipples may be found, varying in diameter from 3 to 3 5-16 ins. on the outside of the male thread, and each of these pitches and each of these diameters may further be rendered different by a different degree of sharpness of the V-shaped thread.

Not satisfied with this immense variety, moreover, new customers are constantly adding more, as new chief engineers of railways are (or used to be, for the practice has decreased) constantly designing new rail sections, each appearing to feel that their right of judgment as to the "disposal of material" ought to be practically asserted. As respects fire-hose, this is particularly senseless and dangerous, since in all really great fires it is necessary to call on surrounding cities and towns for assistance. In the great Chicago fire of 1871, for example, the fire began Sunday evening (Oct. 8), and burned all day Monday and until Tuesday morning, before the last house burned took fire. Here there was time even to bring on fire engines from New York, and in case of a great fire in New York, engines could easily be brought from Philadelphia in 2 hours, and from Boston in 5 hours; but the fire hose of no one of these cities will intercouple! The estimated cost of doing away with this confusion is not large. For cities like Lawrence, Haverhill and Fitchburg, with 20,000 to 40,000 population, and perhaps 10,000 ft. of hose, it is estimated at less than $400, or one or two cents per inhabitant. But while everyone admits in the abstract that this ought to be done once for all, every city wants their coupling to be made the standard, and so no progress is made.

The expediency of very heavy rail sections has evidently impressed itself strongly upon the mind of some unknown subscriber to this journal, who sends us as a "Happy New Year, '91," a "life-size" section of a **400**-lb. rail section, of strictly original design beyond question, and which we have no doubt would excite interest if referred to the Am. Soc. C. E. committee on rail sections. It might not unreasonably be claimed to be the "limit" toward which we are steadily approximating. It has the generous proportions of 11 ins. base by 10¼ ins. height, and in other details is at least unusual. The top corners, for instance, are rounded off by a 1-in. radius, which does not strike one as so very excessive on the drawing, but which yet goes somewhat beyond the most extreme proposals heretofore made. On the head it is noted: "If made 0.12 in carbon, it will be too soft," which we apprehend would be very apt to be the case. On the base we are told: "Silicon as good as carbon," and on the neck it is suggested that "Here is the chance for phosphorus to get in its work." The head is curved to a 24-in. radius only, and yet has a noticeable crown, for the head has the generous width of 5$\frac{13}{16}$ ins. If our page were big enough to hold this rail-section, and we had a page to spare for it, we should have been pleased to have engraved it for the amusement of our readers, for it is much more amusing to look at than it is to describe.

Unfortunately, we are obliged not only to indefinitely postpone the presentation of the above described rail section, but also to postpone until our next issue a diagram which will be examined with more lasting interest, if not pleasure, viz.: a diagram giving the total shipping weights of iron single track bridge spans for spans between 20 and 210 ft., and for all the different "maximum" rolling roads which have prevailed since 1875. Of these there have been no less than four since the first of the series, the Cincinnati Southern "Mogul" specifications (1,820 lbs. per lin. ft. rolling load), were adopted as embodying the latest and best practice. The greatest rolling load shown on the diagram is still somewhat below what is at this moment actually proposed by one of our leading lines, viz., a "typical" Decapod loading, followed by 250 lbs. per lineal foot of track; and yet it is as nearly as may be double what was the advanced practice of 1875. How little effect upon the weight and cost of bridges these great differences of live load make will be better seen next week. We will not now enter into further details on this question, but we mention the diagram in advance of its appearance in order that it may have a double chance of reaching the eye of all those interested in bridge construction, which includes a very large proportion of our readers.



THIS MAP shows ALL the lines of railway within its limits in their correct geographical position as they stood on Jan. 1 of the current year. For railway lines in process of CONSTRUCTION, under SURVEY, or PROJECTED, see the large scale Maps showing the divisions: EAST OF CHICAGO, The SOUTH, The NORTHWEST, The SOUTHWEST, and ROCKY MOUNTAIN and PACIFIC, issued at frequent intervals as supplements to ENGINEERING NEWS.

CORRECTIONS and ADDITIONS to this map and to all our published data of NEW CONSTRUCTION are especially requested. Every effort is put forth to make our maps ACCURATE and RELIABLE.

ENGINEERING NEWS
SERIES OF MAPS: No. 30
UNITED STATES.
THE RAILWAY CONSTRUCTION OF FIVE CONSECUTIVE YEARS.
TRACK LAID IN 1886 — 8,471 MILES
TRACK LAID IN 1887 — 12,667 MILES
TRACK LAID IN 1888 — 6,679 MILES
TRACK LAID IN 1889 — 5,095 MILES
TRACK LAID IN 1890 — 5,981 MILES
The above includes only main track, laid during each calendar year, on which regular trains are, or are to be run, to do business as common carriers of both freight and passenger traffic; thus excluding sidings, double tracking, lumber or mining roads not carrying passengers, and motor roads carrying passengers but no freight.
150 MILES TO 1 INCH
ONTARIO
QUEBEC
MAINE
MINNESOTA
WISCONSIN
MICHIGAN
IOWA
MISSOURI
KENTUCKY
TENNESSEE
ARKANSAS
W. VA.
VIRGINIA
N. CAROLINA
S. CAROLINA
GEORGIA
ALABAMA
MISSISSIPPI
LA.
FLORIDA
DEL.
NEW YORK
PHILADELPHIA
BOSTON
CHICAGO
Milwaukee
Toledo
ST. LOUIS
Louisville
Duluth
Charleston
CHARLESTON
Wilmington
Mobile
NEW ORLEANS
Galveston
LITTLE ROCK
Bowling Green
Quincy
Natchez
Grand Forks
Winnipeg
Green Bay
La Crosse

The Railway Construction of 1890.

The detailed list of the railway track laid in the United States during the calendar year of 1890, which we present with this issue of ENGINEERING NEWS, shows that the total addition to the railway mileage of the country during the year will not vary much from an even 6,000 miles. Necessarily, as our reports are sent in before the end of the year, the tracklaying up to Jan. 1 on lines where work is in progress has to be estimated. Delayed reports may also cause some additions and changes to our detailed list. On the whole, however, there will be but little change from the above total.

In connection with the statistics we have shown on the accompanying map the location of each line of track laid during the year, together with the exact location of all the railway mileage constructed during each of the preceding four years. Our map thus shows the railway construction of one-half a decade, but in that short period an enormous addition has been made to the mileage heretofore existing. It is not generally appreciated how very large a proportion of the total railway mileage of the country has been constructed during it.

To bring this clearly into view we have compiled from our records the following table and diagrams showing the mileage built in each group of States during each year since 1885, with the per cent. of increase for each year over the total mileage at the end of 1885:

NEW MILEAGE CONSTRUCTED.

Group of States.	Mileage at end of 1885.	Mileage added during 1886.	1887.	1888.	1889.	1890.	Total 5 years.
New Eng..	6,311	40	126	180	80	92	418
Middle	18,475	347	215	200	437	328	1,527
No. Central.	31,502	1.320	1,751	896	687	693	5,347
So. Atlantic.	12,167	914	836	1,174	1,095	1,306	5,325
So. Central..	9,669	319	858	1,022	772	900	3,871
So'western..	22,095	2,472	5,118	1,500	851	975	10,916
No'western..	19,348	2,503	3,144	774	566	991	7,978
Pacific	8,790	556	691	929	604	696	3,466
Total.....	128,562	8,471	12,667	6,679	5,095	5,981	38,893

PERCENTAGE OF INCREASE FROM TOTAL AT END OF 1885.

	In 1 year.	In 2 years.	In 3 years.	In 4 years.	In 5 years.
New England	0.6	2.6	3.8	5.1	6.6
Middle.....	1.8	3.0	4.1	6.0	8.2
North Central	4.1	9.7	12.6	14.7	16.9
South Atlantic....	7.5	14.3	24.0	33.0	43.7
South Central.....	3.2	12.1	22.7	30.7	40.0
South Western	11.1	34.3	41.1	44.9	49.4
North Western...	12.9	29.1	33.1	35.8	41.1
Pacific.....	6.3	14.3	21.8	30.8	38.7
Total, U. S.....	6.5	16.4	21.6	25.5	30.2

The accompanying diagrams show graphically the matter presented in the table. In diagram No. 1 the lines to the *left* of the vertical axis represent the track laid in each group of States prior to Jan. 1, 1886, and those at the *right* represent the track laid during the five years since that date. These latter are divided by short check-marks to show the amounts laid during each year. Otherwise the diagrams sufficiently explain themselves.

The marvelous growth of the railway system of the Southern States is the most noticeable feature of the table. In the 18 States comprised in the South Atlantic, South Central and Southwestern groups 20,112 miles of railway have been constructed during the last five years, an increase of 45.7 per cent., against only 18,781 miles, or 22.2 per cent., in all the rest of the country, a very striking and remarkable evidence of the rapid development of the "New South." The Southwestern group has the greatest per cent. of increase to its credit, viz., 49.4 per cent. Closely following come the South Atlantic, the Northwestern and the South Central groups, with increases of 43.7 per cent., 41.1 per cent. and 40 per cent. respectively. For the whole United States the increase has been 38,893 miles, or 30.1 per cent.

Naturally the addition of nearly 40,000 miles of new railway within so short a period of time has produced changes in the channels of traffic which have not been in every way satisfactory. The present "railway problem" is due largely to this alone. Taken as a whole, however, this 38,800 miles of railway has been a profitable investment. Many unprofitable lines have been constructed, it is true, but this loss has been more than balanced by the increased business on well directed extensions; and with the further development of the tributary territory all but a few of the present unprofitable roads will become paying enterprises.

Turning to the construction of the present year, we give below the mileage of track laid in each State and group of States during the year:

	No. Cos.	No. lines.	Miles.
NEW ENGLAND STATES.			
Me.....	4	4	38
N. H.....	2	2	37
Vt.....	1	1	2
Mass.....	2	2	15
Total..	9	9	92
MIDDLE ATLANTIC STATES.			
N. Y....	3	4	29
N. J	6	6	46
Pa.....	20	27	213
Md	1	1	40
Total..	26	38	328
NORTH CENTRAL STATES.			
Ohio	9	11	217
Mich....	8	10	159
Ind	6	7	81
Ill.....	5	5	121
Wis.....	7	11	115
Total..	35	44	693
SOUTH ATLANTIC STATES.			
Va .. .	10	16	207
W. Va..	5	6	96
N. C....	9	14	285
S. C	4	6	738
Ga	13	13	396
Fla.....	5	5	84
Total .	41	60	1,306

	No. Cos.	No. lines.	Miles.
SOUTH CENTRAL STATES.			
Ky.....	10	15	228
Tenn...	11	12	215
Ala ...	10	23	254
Miss....	5	5	82
La.....	4	4	121
Total.	43	58	900
SOUTHWESTERN STATES.			
Mo.....	8	11	163
Ark.....	7	7	120
Tex.....	13	13	251
Kan....	2	3	80
Colo....	4	7	195
N. Mex.	2	2	60
In. Ter.	4	6	106
Total.	28	49	975
NORTHWESTERN STATES.			
Minn...	2	2	67
Neb	6	6	299
N. Dak.	2	2	38
S. Dak..	4	5	129
Wyo. ..	2	2	60
Mont...	3	8	398
Total.	18	25	991
PACIFIC STATES.			
Cal	4	6	113
Ore	4	4	38
Wash .	11	21	393
Utah...	4	6	114
Idaho..	3	6	.8
Total.	22	43	696

Grand total for the United States, 5,981 miles of track laid on 326 lines by 215 companies.
Total laid for Canada, 649 miles on 24 lines by 19 companies.

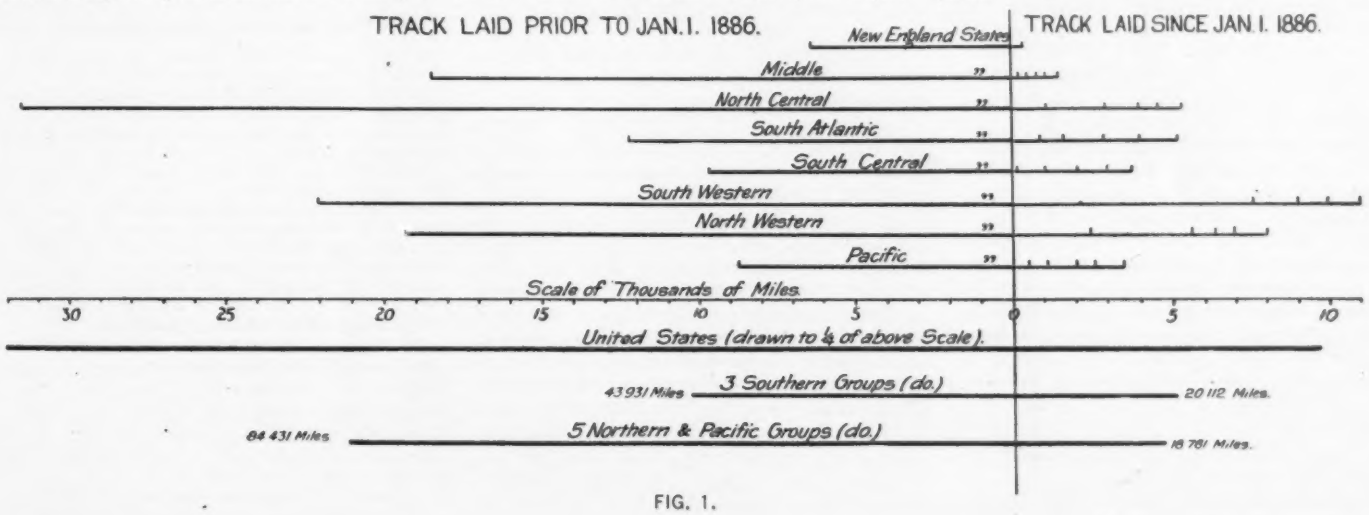

TRACK LAID PRIOR TO JAN. I. 1886.
TRACK LAID SINCE JAN. I. 1886.
New England States
Middle "
North Central "
South Atlantic "
South Central "
South Western "
North Western "
Pacific "
Scale of Thousands of Miles.
30 25 20 15 10 0 5 10
United States (drawn to ¼ of above Scale).
43 931 Miles
3 Southern Groups (do.)
20 112 Miles.
84 431 Miles.
5 Northern & Pacific Groups (do.)
18 781 Miles.

FIG. 1.

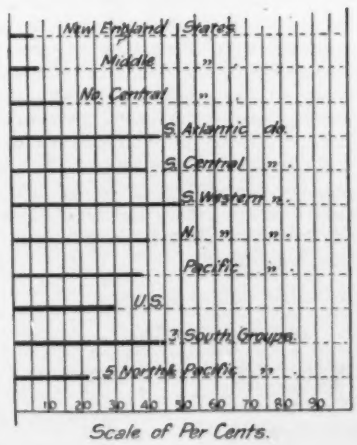


FIG. 2.

As seen by our map, while several long lines have been constructed, the work has been confined principally to building short connecting lines and branches. The work has been done by 215 companies on 326 lines. The average length of each line is, therefore, 18.3 miles.

The field of greatest activity, for this as for previous years, has been the South. In the 11 States east of the Mississippi over 2,200 miles of track have been laid, or 36.6 per cent. of the total. The longest line built in this section, and the longest line constructed wholly within the United States, was the extension of the Seaboard Air Line from Chester, S. C., to the Savannah River, 150 miles. The line will be extended to Atlanta, Ga., and will give the Seaboard Air Line system a road connecting with the Alabama mineral region. In Georgia the Savannah, Americus & Montgomery and the Central R. R. of Georgia have completed the long-talked-of line to Savannah. The Georgia Southern & Florida R. R. has built a long stretch of its Macon-Birmingham line, and the Marietta & North Georgia has completed its extension north to Knoxville, Tenn.

In New England the Maine Central R. R. has built a line 32 miles long. The remainder of the work is confined to short branches and extensions to develop local traffic. On the whole, construction has been more active in this section than it was last year.

The work in the Middle and North Central States was confined with few exceptions to short branches. In Pennsylvania the New York, Ontario & Western has constructed a line into the Lackawanna coal fields, and in Maryland the Baltimore & Eastern Shore has completed its line from Baltimore to the Atlantic coast. The extension of the Pittsburg, Akron & Western from Akron, O., to Carey, O., 109 miles, was the longest line of track laid in either group. This line is projected to give the Pittsburg & Western R. R. a western connection and is being closely paralleled by the Baltimore & Ohio line from Akron to Chicago Junction. About 30 miles of this line has been completed. In the northern Michigan peninsula the Escanaba, Iron Mountain & Western R. R. has built a line from a lake port at Escanaba into the mineral lands around Iron Mountain

In the Southwest the Missouri Pacific Co. has built lines in Missouri and Arkansas. The Choctaw Coal & Ry. Co. has built a considerable mileage in Indian Territory, and in Louisiana and Texas the New Orleans & Northwestern, the Pecos Valley and the Wichita Valley companies have completed lines of considerable length.

The longest line constructed in the Northwest was the Pacific Short Line from Sioux City, Ia., to O'Neill, Neb., 128 miles. This with the lines built by the Burlington & Missouri River, the Chicago, Rock Island & Pacific and the Kearney & Black Hills companies comprise the bulk of the mileage built in this group east of Montana. No track was laid in Iowa during the year.

The work in the Pacific States was confined to a few large companies. In Idaho and Washington the Great Northern, the Northern Pacific and the Union Pacific companies built the greater part of the new mileage. The Great Falls & Canada R. R., from Great Falls, Mont., to Lethbridge, N. W. T., 198 miles, was the longest stretch of track laid during the year. Only 133 miles are within the United States, however. The most active construction was in the Puget Sound region and was done principally by the Northern Pacific and Great Northern companies. The latter company completed a portion of its extension to the Pacific coast and tracklaying is in progress. In California the bulk of the track has been laid by the Southern Pacific Co., and the Rio Grande Western and Union Pacific companies have completed lines of some length in Utah.

Taking the country as a whole, construction has been at least as active as the business to be gained demands. There have been very few wild-cat enterprises and less competitive construction than for some years heretofore. It would seem that the capital put into new railway lines during the present year would prove a paying investment. The prospects for the future, as nearly as we can judge, we noted last week. They may be briefly and truly described as mixed.

Subways and Sewers.

We have received from a firm of civil engineers of Kansas City, Mo., a plan of subway construction, that differs from those already in use in London and elsewhere in but one or two features. The first is the placing of the telephone, telegraph and electric light wires in the bottom of the subway, in a separate conduit; the second departure from usual practice is the separation of the drainage from the subway problem, leaving the two to be worked out on distinct lines.

We think there is something to be said in commendation of the latter feature. The subway disposal of underground fixtures is a modern requirement, made necessary by the mass and variety of such fixtures now seeking space under the streets of our larger cities. The advantages sought in a subway system are (1) The orderly arrangement of the buried pipes, etc.; (2) accessibility to such pipes, for connections, repairs or extensions, without breaking the street surface, and (3) as a result of this disposal, a greater economy in street maintenance, and the advantage of laying the best pavement to start with, with the assurance that a practically perfect surface can be maintained with a minimum of expenditure.

If the drainage system is well designed and properly constructed, with house connections laid to the curb lines during the construction of the sewers, as they should be, there is no reason for breaking the street surface on that account; and the entire separation of the main drainage from the pipe subway is to the advantage of the latter. Unfortunately, it is in our older cities, where the drainage system is antiquated and least perfect, that there is the greatest demand for subways. But even in these cities it would seem that in many cases, if not all, it would be more economical and satisfactory to treat drainage and pipe and wire disposal as two separate problems. Their construction may be carried on distinctly or together, as circumstances may warrant. But as a rule one sewer is all that is needed in a street; and as an equally common rule, two smaller subways, one on each side of the street, meet the demands upon such a subway very much better than one large subway in the middle of the roadway. Connections have to be made with both sides of the street, and these can be provided for in advance in the case of the sewers; but the variety of pipes and wires to be connected, and the fact that this service is new and growing, and novelties are being continually introduced, make it practically impossible to foresee all contingencies during construction in the latter case.

Leaving the drainage to be disposed of as the best practice and local conditions may demand, a similar line of practice can be adopted for the subways. The most serious objection to this orderly disposal of underground pipes and wires is the cost of construction, and this cost is in proportion to the depth of the subway below the street. If a sewer is to form part of the subway, this depth is fixed by the requirements of drainage, regardless of the space actually required for pipes and wires, and this depth may be excessive under certain conditions of the surface undulations. If this sewer is left out, the water pipe, in connection with frost penetration, practically fixes the depth, and this, in a masonry conduit, need not be more than 5 or 6 ft. below the paving level. In other words, a subway built for pipes and wires alone, may require a considerable width at times, but a clear height of 5 ft. would answer all practical requirements, and the floor level may be made to conform with the surface undulations in most cases, and the expense of construction reduced in proportion.

The subway problem must be handled in earnest in the near future in several of our large cities, and the wisdom and necessity of such orderly disposal of pipes and wires is not questioned. The cost of construction is the stumbling block, and it seems to us that the division of systems on the lines pointed out above, would materially reduce this cost and give better results.

CORRESPONDENCE.

The Washington Bridge.

NEW YORK, Dec. 30, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In the article on the Washington Bridge, in your paper of the 27th inst., the writer, following Mr. HUTTON'S book, speaks of the design No. 13 as the "Contract" drawing, and, while giving full credit to all other persons who submitted designs, does not mention the names of the designers of that plan, which has been executed with very little change.

After rejecting all other plans, the Commissioners requested the undersigned to prepare for them plans and specifications upon which contracts might be made. We did so and were paid, as engineers, for so doing.

Those plans and specifications, as indicated by design No. 13, were adopted by the Commissioners and the contracts let according to them. Subsequently, the plan of masonry was modified, as shown in design No. 14, and the price raised accordingly.

Respectfully,

CHARLES MACDONALD.
THOMAS C. CLARKE.

[We make the above correction with pleasure; and regret that full credit was not given in the original article referred to.—ED. ENG. NEWS.]

Placing Cement in Test Moulds.

PHILADELPHIA, Pa., Dec. 23, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: While the subject of testing cement is being discussed in your journal, I would like to know from the manufacturers how the cement is put into the moulds to form the briquettes. You have quite a number of them represented in your advertisements. some of whom guarantee the strength.

I am informed that pressing the cement into the moulds with the *point* of the trowel is being abandoned by some of them for other methods giving higher tests. That the handle of the trowel or the fingers are used with considerable force to *pack* the cement into the moulds; the cement being of the consistency of moist crumbled earth. As this is of as much importance as the shape of the clips in securing uniform tests, I hope *those most interested* will give their experience and methods. J. M. T.

[We give in this issue an interesting article describing the testing laboratory of the St. Louis Water-Works Extension—which includes the placing of the test mortar in the molds. But we would be pleased to have the experience of others also on this point.—ED. ENG. NEWS.]

Buoyancy of the St. Clair Tunnel.

NEW HAVEN, Conn., Dec. 29, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In considering the buoyancy of the St. Clair Tunnel, would not the adhesion of the clay to the cast iron of the lower half of the tunnel add quite a good deal to the resistance to rising?

While receiving a large lot of spruce piling some two years ago, I noticed that in pulling the rafts or bundles in over the mud flats at high water some of the piles would be pressed into the mud from half to the whole of their diameter. They would remain there after the rest of the piles were removed for one to three tides, unless worked out with a tackle. The water would cover them from 2 to 4 ft. Harbor mud is perhaps more tenacious than ordinary clay, but it is also more fluid.

Yours truly, FRANK BRUEN.

[Even the stickiest mud does not adhere with very much force to smooth cast iron, unless it is attempted to separate the two quickly, when the mud acts like a "sucker," and atmospheric pressure may require considerable force to be exerted to cause separation. Again, the buoyancy of a cylindrical body varies as the square of its diameter. The force by which it adheres to a sticky material in which it is imbedded varies only as the diameter. Hence, in the case instanced of the logs, a small one would stick in the mud when a large one would rise. Finally, such a force as the sticking of the clay to the cylinder is too unreliable and uncertain of action to be taken into consideration in calculating the resistance to buoyancy of a permanent structure.—ED. ENG. NEWS.]

Panel Concentrations Due to Engine Loads.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: It will, I think, be admitted that no one needs to be instructed how to find the moment by diagram at any point. Let, then, M_1, M_2, M_3, etc., be the moments thus found at the panel points 1, 2, 3, etc., and let the panel lengths be l_1, l_2, l_3, etc.

Now no one needs to be informed that the moment at any panel joint is equal to the moment at the preceding panel point, *plus* the sum of the preceding concentrations, multiplied by the preceding panel length. This is the principle upon which the diagram itself is based, and which any one who uses it must apply again and again.

Now simply *state* this principle and we have for panel point 6:

$$M_6 = M_5 + (R_1 + R_2 + R_3 + R_4 + R_5)\, l_5$$

or *for equal panels*,

$$R_5 = \frac{M_6}{l} - [5\, R_1 + 4\, R_2 + 3\, R_3 + 2\, R_4].$$

This is literally all there is to Mr. SZLAPKA'S elaborate mathematical discussion which Mr. MARBURG praises so highly. The only difference is that it *holds for any panel lengths, is simpler and requires less figures.* It is self-evident. It is not demonstrated by a "somewhat more direct method;" it is simply a statement in symbols of what any engineer not specially eminent might be expected to know. As it is written down directly it is un-

necessary, because the special results for any case can be written down directly also with equal ease and without reference to any formula. In so simple a matter formulas are not only unnecessary, they are not even desirable. They are no aid. This is not an assertion that rare occasions do not occur when we wish to find successive panel concentrations, but that, when they do arise, formulas are unnecessary.

That Mr. MARBURG does not recognize this result as of greater simplicity and requiring fewer figures is probably due to the clumsy notation of his friend. If he will solve a case, he wil probably admit both claims.

Mr. SZLAPKA'S result would give *for equal panels* $R_0 = \frac{M_6}{l} - \left[5R_1 + 4R_2 + 3R_3 + 2R_4\right]$. Which is the simpler, or requires fewer figures? There could be no better commentary than is furnished by Mr. MARBURG, in criticising a result entirely due to Mr. SZLAPKA'S notation, while both run so entirely unconscious of the simple result which renders such notation a real hindrance and such formulas worthless.

Is it "unfair" or "unwarranted" to say that all this is obvious? What then is to be said of one who insults the intelligence of a multitude of colleagues by saying that this application of the moment diagram is "by no means generally known"? How many are there who would hesitate an instant in writing down this obvious result offhand, or who would think it the subject for an elaborate paper afterwards? When a writer labors with columns of mathematical gymnastics to *deduce* by clumsy notation and tedious reductions a perfectly self-evident result, covers a well-known principle out of sight with mathematical rubbish, fails finally even to recognize the principle itself, is it "unfair" or "unwarranted" to point out that such discussions are unnecessary? I leave the answers to your readers. D.

The Am. Soc. C. E. Engravings—Explanatory.

NEW YORK, Dec. 27, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In your issue of this week, illustrations of street railway track appear which are reproduced from the advance copy of my paper read at the Am. Soc. C. E. meeting, on the 18th inst. They furnish the theme for a criticism of the conduct of the business management of the affairs of that society, and I desire in justice to that management to offer a few words of explanation:

The illustrations you comment upon were not intended for publication in that form. The advance copy is headed by a note which it was hoped would protect them as well as any mistakes in the text from premature exhibition. The note runs thus:

"This advance copy is subject to revision. It is sent to you personally for discussion only, and with the express understanding that it is not to be published or furnished for publication in advance of its regular issue in the Transactions of the Society."

I am alone responsible for the roughness of the sketches which you illustrate; it was particularly notified to me by Mr. BOGART that they would have to be redrawn, but I gave him no time to do it for the advance copy. Working myself very late, and plying him with text and drawings up to the day before the reading, it was impossible for the secretary to do as he desired. Some of them were left out altogether and only appeared as wall diagrams and others were put in roughly as shown in your illustrations.

As a matter of course the sketches are being redrawn for the regular issue of the Transactions. I must say in addition that, taxing as I did the patience and courtesy of Mr. BOGART and his assistants, I feel very sensible of the kindness of their efforts to secure me a hearing at very short notice.

Feeling sure that you will be glad to receive and publish this explanation, I am very respectfully yours,

F. GRAHAM GRIBBLE.

We give place to this explanation with pleasure, but it strikes us as an explanation which does not explain. The drawings might at least have been reduced to some reasonable and uniform scale, and would then have answered fairly well without redrawing. To engrave them once for advance copies, and then engrave them over again for the final publication is by no means a "matter of course," but an unusual and unnecessary extravagance, which we cannot believe was originally contemplated, though it may now be contemplated; for the engravings and plates were neither better nor worse in style and economy of space than hundreds of others which have appeared in the last few years, and they were expressly stated to be reproduced as such, and not as anything exceptional. They chanced to be selected only as from the latest paper published. We did not and do not blame Mr. GRIBBLE for the "roughness of the sketches." They were rather better than those which we and others usually receive for publication. They needed only a little touching up, and a reasonable critical examination for missing details, to have been all right. The "Advance Copy" notice quoted is a well-understood precaution to facilitate minor corrections and prevent premature publication in full. It is not at all intended to prevent publication in abstract nor to cover complete remaking of engravings. If such haste and extra expense to get the paper ready was necessary, how does it happen that other societies give no evidence of the same trouble in their publications? There should not, and there need not be any such dearth of material as to require it.—ED. ENG. NEWS.]

The Manufacture of Aluminum.

PITTSBURG, Pa., Dec. 27, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I note an article in your issue of Dec. 20, page 559, regarding the "Mt. Carmel Aerial Navigation Co.," in which you quote—perhaps from some other authority—that the small cost of the first ship is due to the fact that the company manufactures its own aluminum. I should be very much obliged if you will let me know further in reference to this any data which you may have. The Pittsburg Reduction Co, so far as we know, are the only manufacturers of pure aluminum in this country, and we find our business impeded and our financial standing injured by the many statements printed in the papers, to the effect that other companies are manufacturing aluminum, or have processes for manufacturing aluminum, at wonderfully small costs. In giving quotations for aluminum we are constantly met with the statement that this and that paper says that aluminum is being made, or can be made, by such and such parties at figures much below that at which we are selling the metal. Now, as a matter of fact, as stated before, we find no competition for our aluminum by *actual sales* at less prices than we quote, namely, $2 per lb. We have reduced our prices lately to $2 for all quantities, instead of for large quantities only.

We feel confident that if there were any aluminum on the American market at less than the rates which we quote, we would very soon have the matter brought to our attention by our regular customers, who are paying our price for the metal. As before said, we have as yet experienced no competition from any aluminum manufactured in this country. In so far as we know, we are the only manufacturers of the pure metal in this country, and the Cowles Electric Smelting & Aluminum Co. are the only manufacturers of aluminum alloys other than ourselves. All of the wonderful processes which have been written about in the papers have proven to be either myths, or worse than that, many of them actual frauds.

THE PITTSBURGH REDUCTION CO.

[The note to which our correspondent refers was given only as a press statement. We did not at the time feel the slightest confidence in it, and it was referred to rather as a press absurdity than anything else, though, perhaps, we hardly took pains enough to make this clear. We have understood that the Cowles Co. were now prepared to furnish pure aluminum commercially, but otherwise than that our understanding of the aluminum situation is precisely that given by our correspondent.—ED. ENG. NEWS.]

Methods of Fire Inspection.

BOSTON, Mass., Dec. 27, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I send you herewith a method of inspecting school houses at Lynn, where I have been a member of the school board for a number of years. I have adapted the well known method of insurance inspection reports to a blank for a monthly inspection of school property by the schoolhouse mechanic, who carries a set of these cards in his pocket each month, and as he visits a building in the course of other duties he makes out a report, if he has not already done so, and towards the last part of the month he visits the few buildings, if any, which he has not had occasion to visit in the course of other duties during the month.

I do not know but it is a great way outside of the line of the policy of your paper, but I believe establishments having a large number of buildings should have a systematically recorded inspection of their own, and in this connection I enclose some blanks showing methods of inspection which I have prepared from time to time for the use of several different kinds of mills. Practically all of the largest establishments which we insure maintain their own system of inspection. Our report will probably not be given to the press for about a month.

C. J. H. WOODBURY.

[The blanks enclosed are on a card of ordinary postal card size, on one side of which is the name of the school and blank space for "Special Faults or Remarks," and on the other the following list of details:

Draw a line through words to be specified. Write remarks on other side.

1. YARD—Good Order. Fair Order. Neglected.
2. FENCES—Good Order. Fair Order. Neglected.
3. OUTBUILDINGS—Clean. Fair. Neglected.
4. FLUSH VAULTS—Clean. Good Order. Neglected.
5. WATER CLOSETS—Clean. Good Order. Neglected.
6. SCHOOL ROOMS—Good Order. Fair. Neglected.
7. CELLARS—Good Order. Ashes. Neglected.
8. CLOSETS—Clean. Orderly Neglected.
9. STOVES, FURNACES, STEAM—Good Order. Fair Order. Neglected.
10. VENTILATING APPARATUS—Good Order. Fair. Neglected.
11. SINKS AND FAUCETS—Good Order. Fair. Leaky. Neglected.
12. WINDOWS—Good Order. Out of Order. Glass Broken.
13. Name of Janitor.....

The other blanks, differing somewhat for different works, are prepared to give the following details for every floor of every building, of factories and other works:

Sufficient Casks and Pails, all filled.
Waste and Dirt Boxes, emptied properly and well cared for.
Neatness of Closets and Benches, and Workmen' Drawers
Combustibles in Contact with Steam Pipes.
Unclean Machinery.
General Order of Room.
Hose and Fittings in good order.
Valves to Sprinklers open, and sealed open.
Gas Heaters, etc., safely arranged.
Shellac, Alcohol, Paints and Oils, safely arranged and carefully used.
Safety of Elevator Machinery.
Condition of Elevator Hatches, etc.
Fire Shutters.
Fire Doors and their Latches and Hangings.
Safety of Watch and Repair Lanterns.

Were such careful inspections more common, there would be fewer fires.—ED. ENG. NEWS.]

A Slide Rule Question.

CHATTANOOGA, Tenn., Dec. 23, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Although not a civil engineer, I take your journal regularly and get much valuable information from it. I am much interested in anything appertaining to the slide rule, but rarely see an explanation of it that does not require explaining. Your contributor, MR. WM. COX, in his paper on this subject gives a simple formula:

$$\frac{4 \times 5 \times 6}{8} = 15 .$$

In working this he brings in another factor, 10, which is not explained, and makes an enigma of the whole thing to me. QUIRK.

[There are few explanations of anything which do not still need explaining. The understanding depends simply on what is written and read without further practice and study. In employing the factor 10 in the sentence, "bring 10 on the slide *C* to the runner," Mr. Cox referred to the right slide index. This will be evident if the example is worked out on lines *C* and *D* of a Mannheim rule. The method of procedure is as follows:

Set 8 on slide *C* over 4 on rule *D*, which is equivalent to, divide 4 by 8, = .5. Under 5 on slide *C* is found on rule *D* the product of .5×5 or 2.5, which has now to be multiplied by 6. We do not read off this product 2.5, but bring the runner or slide to it, and then to multiply it by 6, bring the index of the slid to the runner (which in this case is the right hand index, or 10,) and under 6 on the slide *C*, is found 15 on the rule *D*, which is the answer. In this connection we find that in an unknown number of the issue of Dec. 20, several figures were pulled out in printing the formulas at foot of page 544. These can be rereplaced as follows: 2nd formula should read $\sqrt{4 \times 9}$ the 3rd should be $\frac{\sqrt{4 \times 9}}{5}$.—ED. ENG. NEWS.

Further Slide Rule Computations.

NEW YORK, Dec. 17, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Herewith two more formulas for the slide rule, which you may perhaps find worthy of space in your journal. They are each performed with *one single setting* which really seems remarkable.

$\left(\frac{\sqrt{64} \times 12}{9}\right)^2$ Inv.

A..	Under 64.	113.6. Ans.
C...	Set 12.	Over 9.
B..		
D..		

$\sqrt{\frac{7^2 \times 3^2}{6}}$ Inv.

A		
C	Set 3.	Under 6.
B. ..		
D....	Over 7.	Find 8.57 Ans.

I have made a slide rule, with which I can with *one single setting* work out such examples as:

$$\sqrt{7^3 \times 3^2 \times 9} = 63,$$

which I will show you at a later date. WM. COX.

The Mannheim Slide Rule.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I was very much pleased with a paper in your last issue on "The Use of the Mannheim Slide Rule." I am a student in engineering, and have purchased one of those instruments, but I did not fully understand it till I read your article. I have tried everywhere to obtain some literature on the subject; but the books all refer to the "Gunther rule," and I cannot apply the examples to the Mannheim. If you know of any book (in English) that gives some constants, and examples for its use, would you kindly let me know where I might obtain it? I can find no one that understands it, and such a book would be a great help. J. E. Y.

[One of Weale's series is devoted to the slide rule. The cost, we believe, is 75 cts. But while the Mannheim slide rule (as manufactured by Tavernier-Gravet, of Paris) is an improvement, both mechanically and theoretically, on other forms, and will solve examples at a single operation which others cannot, yet the most important use by far for a slide rule in ordinary practical work is to perform routine simple calculations involving multiplication or division only, especially when a number of similar computations are to be made, as in computing percentages, turning foreign measures into English, etc., etc. Thus we have only to set the slide index (or 1) at 3.28 and we continue any number of feet into meters or meters into feet at a single inspection for each, without resetting; setting at 1.61 we can similarly convert kilometers into miles or vice versa; setting at the sum of any series of numbers, we can compute the percentage which each component number makes of the total, however many or few such numbers may be, and so on.

In answer to several inquiries we would state that the best slide rule by far, in our judgment, is the Mannheim slide rule, manufactured by Tavernier-Gravet, of Paris, and for sale in this country only by Keuffel & Esser, in this city, so far as we know. The same firm makes the next best slide rule (which some may think is better) with celluloid scales.—ED. ENG. NEWS].

Notes and Queries.

Mr. HENRY F. PERLEY, Chief Engineer of the Department of Public Works of Canada, writes: In the list of tests of cement mixed with salt water, page 542 of your issue of Dec. 20, I note that Catasauqua (AM.) gave the best results, and that its breaking strains exceed the German Portland. Can you give me the address of the maker or agent? I would like to have a barrel for my tests. [We do not know the address, but those who do will please advise Mr. PERLEY direct.]

—*Queensland.* The best map of the Dominion of Canada is one published by the Canadian Pacific Ry. Co., copies of which can doubtless be obtained *gratis* by any one having good use for it. It is not for sale, to our knowledge. The best map of the United States depends on the use required. Their name is legion. The handsomest large wall map (about 10 ft. long) is by G. W. Colton & Co., of this city, and costs some $20. Rand, McNally & Co., of Chicago, publish another one more rudely drawn, like most of their maps, but very accurate and complete.

Statistics Showing the Mileage of Railway Track Laid in the United States During the Calendar Year of 1890.

(The following list includes the track laid during the calendar year 1890 on extensions of steam railway lines in the United States and Canada, on which regular trains are, or are to be, run, to do business as common carriers of both freight and passenger traffic; thus excluding sidings, double tracking, lumber or mining branches not carrying passengers, and city lines for passenger traffic only. Where tracklaying is now in progress, the mileage is estimated by the officer making the return to us as closely as possible.)

NEW ENGLAND.

Maine.

Kennebec Central.—Randolph to Togus	5.0
Phillips & Rangeley.—Phillips toward Rangeley	24.0
Portland & Rochester.—In the city of Portland	0.7
Somerset.—Solon to Bingham	8.0
Total	37.70

New Hampshire.

Concord & Montreal.—Franklin to Tilton	4.93
Maine Central.—Quebec Jc. to Stratford Jc	32.4
Total	37.33

Vermont.

Clarendon & Pittsford.—Center Rutland to Rutland	2.0

Massachusetts.

Grafton & Upton.—Hopedale to Milford	1.75
Old Colony.—No. Attleboro to Walpole	12.85
Total	14.60
Total for New England States (nine lines built by nine companies)	91.63

MIDDLE.

New York.

Allegheny & Kinzua.—Branch line	6.0
Between Gilbert and Tayers	2.0
Kinderhook & Hudson.—Niverville to Hudson	18.1
New York, Ontario & Western.—Hancock to Delaware River	2.93
Total	29.03

New Jersey.

Brigantine Beach.—End track to Brigantine Beach	1.5
Delaware, Lackawanna & Western.—Bernardsville to Gladstone	7.4
Lehigh Valley.—Newark to Roselle	6.75
Pennsylvania.—New Lisbon to Brown's Mills	1.78
Philadelphia & Reading.—Mt. Ephraim to Chew's Landing	3.4
Philadelphia & Seashore.—Winslow to Tuckahoe	25.0
Total	45.83

Pennsylvania.

Allegheny & Kinzua.—Between Gilbert and Tayers	6
Morrisons to Kinzua Valley	2.25
Branch line	0.75
Altoona & Wapsonsock.—Altoona to Logan	5
Baltimore & Ohio.—Elwood Jc. to Elwood	3
Coudersport & Port Allegheny.—Coudersport to Swedan Valley	5
Delaware River & Lancaster.—St. Peters to French Creek Jc	12
Diamond Valley. Neff's Mill to Mooresville	0.7
East Broad Top.—On Shade Gap Branch	1.5
Easton & Northern.—End track to Easton Bushkill Station	6.1
Fall Brook Coal Co.—Harrison Valley to mills	2
Lehigh Valley.—Pottsville Branch	34
Mahoning Valley.—Punxsutawney to mines	2
Middletown & Hummelstown.—Swatara Cave to Hummelstown	1.25
New York, Ontario & Western.—Delaware River to Scranton	51.12
Pennsylvania.—New Holland to Lancaster	9.81
Radebaugh branch	7.7
Winfield "	8.33
Banion "	2.19
Kendrick "	0.70
Ednie "	0.34
Philadelphia & Reading.—Hartsville to New Hope	16.
Pittsburg, Shenango & Lake Erie.—Amasa toward Lake Erie	20.
Reynoldsville & Falls Creek.—Reynoldsville to Soldiers Run	6.
Sinnemahoning Valley.—Cut off	2.
Titusville, Cambridge & Lake Erie.—Titusville to Tannery	1.5
Wilkesbarre & Western.—Millsville to Rohrsburg	6.
Total	213.24

Maryland.

Baltimore & Eastern Shore.—Easton to Salisbury	40.
Total for Middle Atlantic States (38 lines built by 26 companies)	378.

NORTH CENTRAL.

Ohio.

Baltimore & Ohio.—Between Chicago Junction and Warwick	30.
Columbus, Hocking Valley & Toledo.—Wallbridge to Rockwell	2.
Columbus, Shawnee & Hocking.—Saltillo to Sayre's Station	11.1
Lancaster & Hamden.—Tarlton to Laurelltown	5.
Laurelltown toward Wellston	10.
Middletown & Cincinnati.—Between Middletown and Cincinnati	5.
Pittsburg, Akron & Western.—Carey to Akron	109.
Toledo & Ohio Central.—Broadwell to Newton	15.
Toledo, Findlay & Springfield.—Between Bowling Green and North Baltimore	5.
Wheeling & Lake Erie.—Laurelton to Steubenville	17.3
Warrenton to Martin's Ferry	7.2
Total	126 6

Michigan.

Alba, East Jordan & Frederick Short Line.—Between Frederick and Jordan	20
Chicago & West Michigan.—Between Baldwin and Traverse City	15
Holland City to Ottawa Branch	7.1
Cincinnati, Saginaw & Muskinaw.—West Bay City to Oa-at-ka Beach	5.66
Escanaba, Iron Mt. & Western.—Escanaba to Iron Mountain	53
Flint & Pere Marquette.—Yale to Port Huron	24
Brown City south	5
Grand Rapids & Indiana.—Jennings Spur Jun. to Lake City	6.93
Manistee & Grand Rapids.—Oak Park to Sable River	9.83
Manistee & Northwestern.—Nesson City north	12
Total	158.52

Indiana.

Cincinnati, Wabash & Michigan.—Anderson to Rushville	38.54
Evansville & Terre Haute.—Sand Creek to Westport	17.25
Hymern to Jackson Hill	3.7
Midland R. R. of Indiana.—Brown's Valley to Vandalia Junction	4.1
New Albany Belt & Terminal.—In city of New Albany	2.
Ohio & Mississippi.—Main line to quarries	6.
Wabash.—Peru to Chili	9.6
Total	81.19

Illinois.

Centralia & Chester.—Coulterville toward Centralia	10.
Chicago & Northwestern.—Montrose to North Evanston	7.60
Chicago, Peoria & St. Louis.—Litchfield to East St. Louis	48.
Louisville, Evansville & St. Louis.—Centralia to Belleville Junction	48.71
St. Louis, Alton & Springfield.—Lock Haven to Elsa	6.3
Total	120.7

Wisconsin.

Chicago, Milwaukee & St. Paul.—Ursulah to Babcock	18.94
Lynn northwest	2.16
Chicago, St. Paul, Minneapolis & Omaha.—Neillsville to Marshfield	23.4
Goodyear, Neillsville & Northern.—Goodyear to McKenna	2.
Branches	5.
Milwaukee, Menominee Falls & Western.—Wisconsin Central R. R. to Sussex	1.6
Port Edwards, Centralia & Northern.—Port Edwards to Nash Hill	17.
Marshfield to Nash Hill	13.
Sault Ste. Marie & Southwestern.—Eleva to Mondovi	9.
Wisconsin Central.—Marshfield to Greenwood	22.5
Total	114.6
Total for Central Northern States (44 lines by 35 companies)	69.3

SOUTH ATLANTIC.

Virginia.

Atlantic & Danville.—Buffalo Jc. to Buffalo	4.
Bellefield to Hitchcock	8.25
Chesapeake & Ohio.—Branch to Ritch Patch iron mines	6.
Between Eagle Rock and New Castle	5.
Farmville & Powhatan.—Sunnyside to Farmville	24.
Louisville & Nasheville.—Cumberland Valley Branch	30
Lynchburg & Durham.—South Boston to State line	10.
Norfolk & Western.—Honaker to Norton	46.5
Ivanhoe to Great Outburst	15.41
Washer to Bettie Creek	6.23
Richlands to coal mines	4.16
Doran to coal mines	1.2
Richmond & Tidewater Coal.—Coal fields to Tomahawk	5.
Richmond, Fredericksburgh & Potomac.—Arca to James River	3.
Roanoke & Salem.—Roanoke to Salem	7.5
Roanoke & Southern.—State line to Martinsville	10.
South Atlantic & Ohio.—Natural Tunnel to Big Stone Gap	21.
Total	207.75

West Virginia.

Chesapeake & Ohio.—Coalburg to Cabin Creek	15
Huntington & Big Sandy.—Huntington to Kenova	5
Kanawha.—Fairfield to Acme	9.5
Monongahela River.—Shinston to Clarksburg	15
West Virginia & Pittsburg.—Buckhannon to Shelbyville	25
Weston to Burnsville	26
Total	95.5

North Carolina.

Albemarle & Pantigo.—End track to Belle Haven	4.5
End track to Crosswell	4
Atlantic & Danville.—Viscariel to Blue Wing Creek	3.25
Atlantic Coast Line.—Greenville to Kinston	28
Cape Fear & Yadkin Valley.—Mt. Airy to Flat Rock	2.02
Rosboro to Fayetteville	23
Melboro to Ramseur	9.24
Lynchburg & Durham.—Virginia State line to Durham	41.4
Richmond & Danville.—Silvan to Wilkesboro	42.
Salisbury to Bilesville	24.
Andrews to Tomotla	10.
Roanoke & Southern.—Walnut Cove to Virginia line	33.
Wilmington, Chadbourne & Conway.—Chadbourne to mills	11.
Wilmington, Onslow & East Carolina.—Wilmington to Jacksonville	50.
Total	285.4

South Carolina.

Charleston, Sumter & Northern.—Eatonville to Pine Bluff	6.
Bennettsville south	30.
Columbia, Newberry & Laurens.—Broad River to Newberry	42.
Newberry to Jalapa	7.
East Shore Terminal.—In city of Charleston	3.
Seaboard Air Line.—Chester to Savannah River	150.
Total	238

Georgia.

Abbeville & Way Cross.—Abbeville to Swan	23.
Albany, Florida & Northern.—Albany to Cordele	35.
Central R.R. of Georgia.—Pembroke to Lyons	42.75
Chattanooga Southern.—Tennessee line to Broncho	27.
Columbus Southern.—Weston to Albany	39.68
Georgia, Midland & Gulf.—In city of Columbus	1.25
Georgia, Southern & Florida.—Macon to La Grange	95.
Macon, Dublin & Savannah.—Macon toward Dublin	25.
Middle Georgia & Atlantic.—Eatonton to Covington	38.
Savannah, Americus & Montgomery.—Oconee River to Lyons	20.
Louvale to Alabama line	13.66
South Bound.—Savanah to Montieth	12.
Way Cross Air Line.—Way Cross west	21.
Total	396.34

Florida.

Florida Central & Peninsular.—Plant City to Tampa	22.84
Georgia Southern & Florida.—Mile post 232 to mile post 260	34.
Osceola & Lake Jessup.—Lakemont to Oviedo	10.
St. Augustine & North Beach.—St. Augustine to North Beach	5.
Suwanee River.—End track to Hattyburg	12.
Total	83.84
Total South Atlantic States (60 lines by 41 companies)	1,276.

SOUTH CENTRAL.

Kentucky.

Chesapeake & Ohio.—Stone City to Quarries	9
Hawksnest to mines	4
Kentucky Union.—Lexington to Winchester	20
Kentucky River to New Jackson	23
Chenowee to Inverness	7.6
Kinneconick & Freestone.—Kinneconick to mines	9
Knoxville, Cumberland Gap & Louisville.—Cumberland Gap to Middlesborough	3
Lexington Belt.—At Lexington	8
Louisville, St. Louis & Texas.—End track to Fordsville	13
Fisher's Jun. to Falls of Rough	4.4
Louisville Southern.—Versailles to Richmond	36.86
Middlesborough Belt.—Belt line around City of Middlesborough	11.15
Bennett's Fork Branch	5.25
Owensboro, Falls of Rough & Green River.—Fair grounds L. St. L. & T. R. R.	0.5
Paducah, Tennessee & Alabama.—Paducah to Tennessee line	73
Total	227.7

Tennessee.

Bristol, Elizabethtown & North Carolina.—Bristol toward Elizabethtown	10
Charleston, Cincinnati & Chicago.—Johnson City to North Carolina line	23
Johnson City north	14
East Tennessee, Virginia & Georgia.—Johnson City toward Ashville	10
Genesis & Obed River.—Johnson Stand toward Crossville	3
Harriman Belt.—At Harriman	2.4
Knoxville Southern.—Between Georgia line and Knoxville	80
Middle & East Tennessee.—Hartsville Junction to Hartsville	11.5
Nashville & Knoxville.—Curry Fork River to Cookville	11.5
Nashville, Chattanooga & St. Louis.—Dunlap to Pikeville	20
Paducah, Tennessee & Alabama.—Kentucky line to Paris	15
Paint Rock Coal & Coke Co.—Amida to mines	4.5
Total	215.4

Alabama.

Alabama Midland.—West of Troy to end track	22.
Rutledge to Julien	4.
Birmingham & Jones Valley.—Birmingham to Avondale	2.
Birmingham, Sheffield & Tennessee River.—Jasper to Parrish	9.
Margerum to Riverton	11.
Chattanooga Southern.—Gadsden north	12.
East Tennessee, Virginia & Georgia.—Savage Creek to Blockton	12.
Gurnee to Bessemer	20.
Escambia.—Sullivan north	27.
Georgia Pacific.—North Birmingham to Coalburg	7.
Gadsden & Attalla Union.—Gadsden to Belle View Highlands	12.
Laney Jackson Lumber Co.—Near Laney	4.
Louisville & Nashville.—Mildale to mines	5.
Red Gap to Graces	10.09
Boyles to Birmingham	2.09
Helena to Gournee	10.
Sylacauga to Calera	30.
Montgomery, Tuscaloosa & Memphis.—Montgomery west	0.5
Nashville, Chattanooga & St. Louis.—Littleton to near Guntersville	19.
Savannah, Americus & Montgomery.—Hartsboro southwest	8
Seaboard Ry. of Alabama.—Mannahubba to Senis Chapel	16.
Talladega & Coosa Valley.—Renfroe to Cooks	8.
Tennessee River, Asheville & Coosa.—Asheville to Whitney	3.
Total	253.68

Mississippi.

Georgia Pacific.—Itta Bena to Webb	34.7
Louisville, New Orleans & Texas.—Clarksdale to Minter City	39.6
Meridian.—Meridian to Bonita Park	2.
New Orleans & Northwestern.—Natchez to Magnolia Station	3.
Poplar Springs, Handley's Lake & Meridian.—Meridian to Poplar Springs	2.5
Total	81.8

Louisiana.

Kansas City, Watkins & Gulf.—Lake Charles, north	10.
Missouri Pacific.—Arkansas line to Mer Rouge	19.41
New Orleans & Northwestern.—Sycamore Station to Rayville	66.
New Orleans, Fort Jackson & Grand Isle.—End track south	26.
Total	121.
Total Gulf and Mississippi Valley States, (58 lines built by 43 companies)	900.

SOUTHWESTERN.

Arkansas.

Brinkley, Helena & Indian Bay.—Main line to Janus	3.
Cache River Valley.—Shotwells to gravel pit	20.
Louisiana, Arkansas & Missouri.—Tripp Jc. to Amburn's	5.5
Louisville, New Orleans & Texas.—Incline at Helena	9.
Mississippi & Little Rock.—Between, Duncan and Little Rock	30.
Missouri Pacific.—McGehee to Louisiana line	27.26
Stuttgart & Arkansas River.—Stuttgart to Dewitt	25.
Total	120.

Missouri.

Chicago, St. Paul & Kansas City.—Bee Creek to Beverley, Jc	23.
Haines, Hamilton & Kingston.—Hamilton to Kingston	8.
Kansas City, Fort Smith & Southern.—Splitlog to Piersville	10.
Kansas City, Nevada & Fort Smith.—Grand View to Amoret	47.
Kansas City Suburban Belt.—Kansas City to Brush Creek	12.
Missouri Pacific.—Fort Scott to Rich Hill	26.27
In Booneville	1.
In Carthage	1.
Joplin southwest	2.5
Rockport, Langdon & Northern.—Langdon northwest	6.
St. Louis, Kinnett & Southern.—Campbell to Kinnett	25.
Total	163.

Texas.

Denison, Bonham & New Orleans.—Bonham toward Denison	10
Ft. Worth & Rio Grande.—Dublin to Comanche	22
Gulf, Brazos Valley & Pacific.—Milsaps to Mineral Wells	10
Haines Medina Valley.—Castroville to Lacosta	7
Houston & Texas Central.—Hutchinson to Lancaster	5
Houston Belt & Magnolia Park.—In city of Houston	6
Missouri, Kansas & Texas.—Waxahatchie toward Hillsboro	20
Pecos Valley.—Pecos City to New Mexico line	50
San Antonio & Aransas Pass.—Between West Point and Waco	12
Sherman, Denison & Dallas.—Denison to Sherman	9.53
Weatherford, Mineral Wells & Northwestern.—Weatherford to Mineral Wells	23
Wichita Valley.—Wichita Falls to Seymour	51
Yellow Pine Lumber.—End track east	25
Total	251.

Kansas.

Missouri Pacific.—Fort Scott Belt Line	4.75
Fort Scott to Minden Jc	25.28
Omaha, Hutchison & Gulf.—Kingston to the State line	50.3
Total	80.

Colorado.

Denver & Rio Grande.—Villa Grove to Alamosa	54.02
Rifle to Grand Jc	62.08
Manitou to Pikes Peak	9.
Little Book Cliff.—Grand Jc. to Little Book Cliff	11.
Rio Grande Southern.—Dallas to Telluride	43.2
Branch	9.
Union Pacific.—Martinsen to New Mexico	3.89
Road Jc. to Berwind	2.82
Total	196.

New Mexico.

Pecos River.—Texas line to Eddly	40.
Union Pacific.—Colorado State line to Red River	20.11
Total	60.

Indian Territory.

Atchison, Topeka & Santa Fe.—Ardhmore to mines	4.5
Chicago, Rock Island & Pacific.—Okarche to Mexico	29.5
Chartiers Coal & Railway Co.—Hartshorn to Wister	50.
Somca west	2.
Fort Reno east	15.
Missouri Pacific.—Cherokee Jc. south	4.9
Total	106.
Total entire Southern States (49 lines built by 28 companies)	975.

NORTHWESTERN.

Minnesota.

Northern Pacific.—Crookston to Carthage	22.1
Winona & Southwestern.—Utica to Spring Valley	46.0
Total	67.

Nebraska.

Chicago, Rock Island & Pacific—South Omaha to Lincoln	54.68
Chicago, St. Paul, Minneapolis & Omaha.—Wayne to Bloomfield	21.8
Kearney & Black Hills.—Kearney to Calloway	66.00
Missouri Pacific.—Union north	25.00
Pacific Short Line.—Sioux City to O'Neill	128.5
Union Pacific.—Nantucket to Pleasonton	3.02
Total	299.

North Dakota.

Great Northern.—Grafton to Cavalier	32.
Northern Pacific.—Great Bend to Keystone	6.
Total	38.

South Dakota.

Black Hills & Ft. Pierre.—Mowatts to Piedmont	14.6
Burlington & Missouri River.—Edgemont to Mystic	74.8
Chicago & Northwestern.—Buffalo Gap to Hot Springs	13.25
Whitewood to Deadwood	10.
Forest City & Southeastern.—Forest City to Gettysburg	16.
Total	129.

Montana.

Great Northern.—Pacific Junction to Shelby Junction	101.0
Beulah to Monarch	31.1
Montana & Canada.—Great Falls to International line	133.
Northern Pacific.—Between Logan & Butte	13.1
End track to Elkhorn	8.7
Suppington to Norris	10 8
Harrison to Pony	7.1
De Smet to St. Regis	93.6
Total	398.
Total Northwestern States (25 lines built by 18 companies)	991.

Wyoming.

Burlington & Missouri River.—New Castle to Merino	28.3
Union Pacific.—Wendover to Orin Junction	31.41
Total	60

PACIFIC.

California.

Nevada-California-Oregon.—Liegen to Amedee	9.
Pajaro Valley.—Watsonville south	12.
San Diego, Cayumaca & Eastern.—Lakeside to Foster	4.
Southern Pacific.—Oakdale to Merced	39.33
Picnic Grove to Marysville	18.3
Los Banos south	30.
Total	113.

Oregon.

Astoria & South Coast.—Astoria south	5.
Jacksonville & Medford.—Jacksonville to Medford	10.
Northern Pacific.—Hunters to Goble	2.
Union Pacific.—La Grande to Elgin	20.89
Total	37.89

Washington.

Bellingham Bay & British Columbia.—New Whatcom to British Columbia line	23.5
Fidalgo City & Anacortes.—Fidalgo City to Anacortes	11.
Great Northern.—Fairhaven to International line	30.
Branch to mines	4.
Mason County Central.—Branch to mills	4.
Northern Pacific.—Cheney to Coulee City	21.
Belmont to Farmington	6.1
Burnett to Pittsboro	22.9
Lake View to Harlowe Jc.	24.7
Centralia to Acosta	32.6
Seattle Belt Line	2.5
Palmer to Niblocks	7.5
Kalma to Goble	0.4
Pullman-Lewiston line	15.7
Three miles north of Snohomish north	64.
Tacoma Belt	5.
Port Townsend Southern.—Port Townsend to Lake Hooker	20.2
Puget Sound & Gray's Harbor.—Montesano to Montesano Dock	1.5
Logging Branch	3.
Seattle Northern.—Anacortes to Hamilton	36.
Seattle Terminal.—Seattle to West Seattle	3.05
Spokane Falls & Northern.—Mission Station to Little Dallas	46
Vancouver, Klickitat & Yakima.—End track east	4.
Total	392.75

Utah.

Ogden & Hot Springs.—Ogden to Hot Springs	7.
Rio Grande Western.—Thistle to Manti	60.
Union Pacific.—Between Ogden and Idaho line	19.26
Milford to Urton	6.26
Utah Central.—Salt Lake City to Monahansett	10.
Park City east	10.
Total	113.52

Idaho.

Northern Pacific.—Mullan to St. Regis	11.1
Pullman east	7.0
Union Pacific.—Wallace to Mullan	6 43
Wallace to Burke	6 7
Utah State line to McCannon	3.34
Wallace & Sunset.—Wallace up Nine Mile Creek	3.5
Total	38.07
Total Pacific States (43 lines built by 22 companies)	6.96

CANADA.

Ontario and Eastern Provinces.

Canadian Pacific.—Ste. Jerome to Shawbridge	10
Cornwallis Valley.—Kingsport to Kentville	15.
Drummond County.—Drummondsville to Ste. Rosalie	27.
Great Northern.—New Glasgow to Cadottes	9.
International.—North Sidwey to Sidwey, Jc	5.
Lower Laurentian.—End track east	10.
Montreal & Ottawa.—Hudson to Rigaud	8.
Ottawa & Gatineau Valley.—Hull Jc. to 10th mile post	10.
The Lake Temiscamingue.—On main line	16.
Tobique Valley.—End track toward Plaster Rock	3.3
Temiscouata.—Edmundston to Clairs	22.
Western Counties.—Annapolis to Bear River	14.
Total, Ontario and Eastern Provinces (42 lines built by 12 companies)	143

Manitoba.

Calgary & Edmonton.—Calgary north	110.
Canadian Pacific.—End track to Prince Albert	138.4
Souris to Melita	41.5
Great Northwest Central.—End of track north	50
Manitoba & Northwestern.—Saltcoats to Yorkton	17.53
Northern Pacific & Manitoba.—End track to Brandon	5.
Port Arthur, Duluth & Western.—Port Arthur to Fort William	6.
Kaministiqua River toward International line	23.
Total Manitoba (8 lines built by 7 companies)	391.

British Columbia.

Canadian Pacific.—Mission Station south	10.
Sproats to Kootenai Lake	30.
Great Falls & Canada.—International line to Leithbridge	65.
Great Northern.—New Westminister to International line	20.
Total.—British Columbia (4 lines built by 3 companies)	115.

Experiments on the Permeability of Brick.

BY A. W. HALE, ASSISTANT ENGINEER NEW CROTON AQUEDUCT, NEW YORK CITY.

The following paper embodies the substance of a report on the results of experiments ordered by the Aqueduct Commission for the purpose of determining the permeability under pressure of common brick, cement brick and coated brick.

In the spring of 1888 samples of brick and cement were prepared by the Aqueduct Commission for the

purpose of ascertaining the percolation of water under pressure through a wall properly built of such material as had been used in the construction of the new Croton Aqueduct. Preliminary tests having indicated that the methods generally adopted for determining the percolation of water through a porous material, such as brick, could not be relied upon, a method applicable to the particular line of experiments proposed was devised and a suitable apparatus constructed.

Owing to the peculiar design of a portion of the new aqueduct, which is under a very high pressure, it was thought that a more impervious surface than that furnished by common brick masonry would be desirable in order to reduce the expected percolation to a minimum. Hence, originated the idea of testing a number of materials and coatings, with the ultimate purpose of selecting the best and most economical method for attaining the desired result.

The experiments which follow were entrusted to the writer, who, in regard to them, was in constant consultation with the chief engineer, Mr. A. FTELEY, with respect to the conduct of the work.

The apparatus already provided being, with slight modifications, applicable also to the testing of the effect upon permeability of a coating applied to the surface of a brick, it was decided, pending the maturing of the samples above mentioned, to test various materials for this purpose which had been submitted or suggested. It is the results of these latter experiments more especially that are here given.

The points to be considered are:

1. The scope of the investigation.
2. Method.
3. Apparatus.
4. Manipulation.
5. Results and conclusions.

Scope of the Investigation.—For the purpose of arriving at definite and trustworthy conclusions, the tests made and required were of several sorts:

1. Tentative and negative experiments, for the purpose of learning what might be expected of certain methods suggested or found in technical works bearing upon the subject.

2. Experiments for determining the percolation of water through brick. These were confined to the common brick used largely in the lining of the aqueduct.

3. The percolation, through the same brick, under different pressures.

4. The percolation, through the same brick, in opposite directions.

5. The percolation, through the same brick, of water made turbid with clay.

6. The percolation, through the same brick, of water with an infusion of clay, under different pressures.

7. The percolation, through the same brick, of clear water, after the treatment with clay.

8. The percolation, through the same brick, of clear water, after the brick had been reversed, the clay partially removed by a flow under pressure, and the brick again reversed.

9. The percolation, through the same brick, under the same conditions and different pressures.

10. The percolation through cement brick made of different brands of cement, neat, and with two parts of sand to one of cement.

11. The percolation through the same cement brick in opposite directions.

12. The effect of long exposure to the open air of repeated coats of the various solutions submitted.

13. The percolation through brick coated with these solutions.

14. The percolation through brick coated with Portland cement.

15. The percolation through brick coated with Portland cement, after setting six months.

16. The change in the rate of percolation through a brick coated with Portland cement, after having been kept under a water pressure of 80 lbs. per sq. in. for two months.

17. Experiments relating to methods of application of cement, and the effect of various admixtures.

Only such of the results of the above experiments as can be be definitely stated are here given.

Method.—The points to be considered in choosing a method are, (1) the direction of flow of the

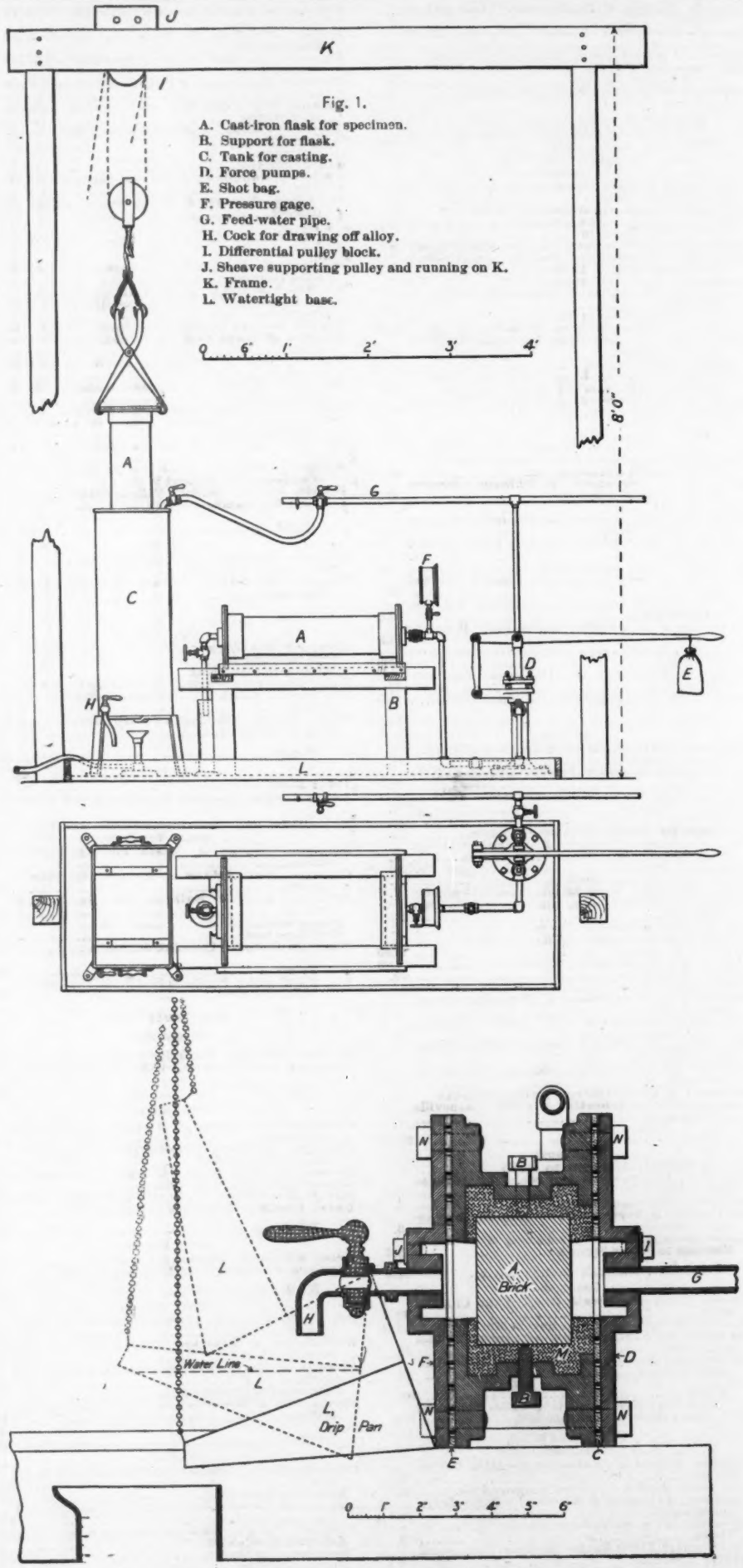


FIG. 3. VERTICAL SECTION OF BRICK AND FLASK.

A. Brick. B. Set screws for adjusting brick. C. Perforated rubber gasket cemented to D. D. Induction plate. E. Perforated rubber gasket cemented to F. F. Eduction plate. G, Pipe connecting with test pumps. H. Cock. I, J. Screws closing air vent. K. Graduated glass measure. L. Drip pan. Alloy inclosing brick. N. Twenty tool steel bolts.

water; (2) the size and shape of the sample; (3) the most effective means for securing an impervious joint.

The direction of flow of water through a brick is in general, perpendicular to the face, as laid, perpendicular to the bed, as tested.

In common brick, the face, back and bed have a partially vitrified sand coating, while the top has none; hence, there is a difference in the permeability perpendicular to the bed and to the face.

In these two directions the material is also differently distributed; sections of brick showing a tendency to a distribution of the numerous cavities, parallel to the bed; hence, for this reason also, the permeability is likely to vary with the direction of the flow of water.

Experiments have been made in this country upon brick through which the water was forced endwise, and in France experiments have been made small cylinderr, the direction of flow with reference to the structure of the material being undefined.

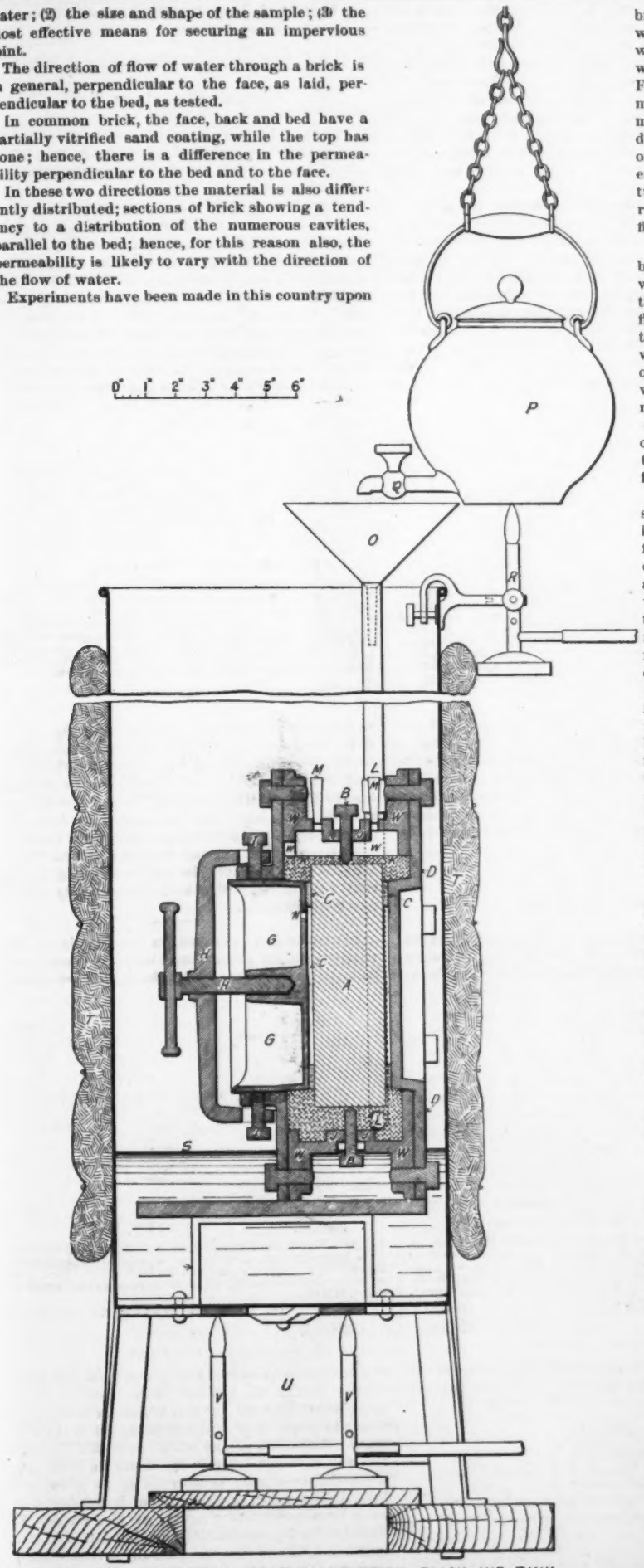


FIG. 2.—VERTICAL SECTION OF BRICK, FLASK AND TANK.

A. Brick. B. Set screws for adjusting brick. C. Rubber gasket cemented to D. D. Lower plate. E. Upper plate. F. Rubber gasket cemented to G. G. Follower. H. Yoke and screw. I. Set screws. J. Recess in side of flask for securing a tight joint. K. Surface of alloy. L. Gate. M. Sprues for raising level of vent. N. Vent for air inclosed in brick. O. Brazed brass funnel. P. Ungalvanized iron kettle. Q. Cock. R. Gas burner for heating alloy. S. Surface of water in boiler. T. Hair felt and enameled cloth jacket. U. Asbestos paper apron. V. Six Bunsen burners for heating boiler. W. Cast-iron flask.

In the case of brick as laid, the water entering through one face flows out through the opposite face, while in the case of experiments, as very generally made, the water entering through one face finds exit through five faces.

As to size and shape of samples, in order to conform to the normal conditions as far as practicable, it was decided to test whole brick rather than fragments, and to so construct the apparatus that the flow might be made perpendicular to either the face or bed, and so that the water should enter through one face and escape through the opposite face only.

To secure an impervious joint India rubber gaskets have generally been used. Under high pressures these were found to be ineffective. For these gaskets it was decided to substitute a metallic joint secured by casting ("lead-ing") the brick in a cast iron flask.

The apparatus required consists of (1) a cast-iron flask for holding the specimen, (2) a jacketed boiler iron tank for raising the temperature of the flask during the casting, and also for melting out the alloy, (3) a test pump with pressure gauge, (4) apparatus for supporting and handling the flasks, (5 vessels for measuring the escaping water. The general arrangement of the apparatus is shown in Fig. 1.

Flask.—Flasks were provided both for specimens of brick and mortar and for brick only. Those for blocks of brick and mortar were of several sizes; the largest, for a block from a 24-in. wall is shown at *A*, Fig. 1.

The flasks for brick are of two sizes; one so proportioned as to adapt itself to brick of any size from Maine to Stourbridge fire brick, and the other designed for the common Croton brick only.

This last, which is the only one that need be considered in detail, is shown in vertical section in Fig. 2, together with the disposition of the appliances for casting; and in cross section in Fig. 3, which shows the flask connected with the force pump, in position for testing.

A tight joint between alloy, brick and flask is secured whether the alloy contract or expand in cooling by means of a recess in the flask shown at *J*, Fig. 2. The alloy will expand (if it does expand) between opposing faces of brick and flask, and contract (if it does contract) upon opposite faces of brick and recess. All opposing faces acting as a joint for the retention of the alloy were faced, scraped and oiled.

Presence of water in the flask does not interfere with the casting, but an imperfect adhesion of the alloy to the brick at its upper end may be produced by an accumulation at that point of heated air driven out from the brick in the process of casting. This is avoided by making a vent *N*, Fig. 2, for the escape of air from the brick through the follower *G*. Shrinkage of the alloy in cooling and leakage through the joints is compensated for by the sprues M, Fig. 2.

Alloy.—Of ten alloys tested, one composed of 8 parts by weight of lead, 4 of tin, 15 of bismuth and 3 of cadmium was found to give the best results. This alloy melts at 158° Fahr.; is hard, tough, extremely limpid when fused; contracts in cooling, and expands slightly in congealing; adheres firmly to brick, but not to brass or iron (not galvanized or tinned). When kept long at a high temperature its constituents tend to separate according to their specific gravities, which is obviated by vigorous stirring before pouring. At a high temperature it also oxidizes and volatilizes, with a loss, particularly of cadmium, which is obviated by keeping it constantly covered with water when melted.

Gaskets.—India rubber under high pressures failed to make a tight joint between flask and plate, and heavy oak sole leather was substituted with, at first, good results. Under high pressures, however, there was a constant escape of inky water, the leather finally becoming as hard as raw hide.

India rubber perforated with holes 3-16 in. in diameter and ⅛ in. apart in the clear, was then substituted for the leather, with results that were entirely satisfactory.

Manipulation.—The flask *A*, Fig. 1, with specimen, was placed in the boiler *C*; the temperature raised to 212° Fahr., and the alloy for sealing the specimen poured. The flask was then connected with the force pump *D*, tested, and returned to the boiler *C*, which was filled with hot water. The alloy was thus melted out and drawn off by the cock *I*.

The brick *A*, Fig. 2, was adjusted by set screws *B* upon the rubber gasket *C*, cemented to the plate *D*. The upper plate *E* was bolted to the flask; the rubber gasket *F*, cemented to the follower *G*, was pressed against the brick by means of the yoke and screw *H*, and the follower clamped by the set screws *I*. The plate *E* with the follower was then removed, and the joint between follower and plate calked with oakum and sealed with plaster of Paris. The plate and follower were replaced and the alloy poured.

The plates *D* and *E* were then removed, and plate *D* replaced by the eduction plate *F* and rubber gasket *E*, Fig. 3; the flask bolted to the induction plate *D* and gasket *C*, and the specimen tested.

The presence of air and impurities in the water having been found to interfere materially with the constancy of results, the feed-water was boiled and filtered, and the flask freed from air before each test by means of the vents *I* and *J*, Fig. 3.

Tests.—The pressure, regulated by means of a shot bag *E*, Fig. 1, suspended from the handle of the force pump, ranged from 30 to 200 lbs. per sq. in. The temperature of the feed water was, in general, the temperature of the air. The number of observations ranged from 10 to 20 and the constant interval between observations from 5 to 10 minutes. Four measuring cylinders were required, ranging in capacity from 50 to 2,000 cu. cm. Into the smaller cylinders the water dripped through a funnel. For the

larger cylinder, into which the water ran in a constant stream, a drip pan (shown in three positions at *L*, Fig. 3) was required, by drawing and raising which the water was directed either into the measuring cylinder, or retained in the drip pan as a temporary reservoir during the recording of air observation, or allowed to run to waste, dispensing by this arrangement with the labor of an assistant in taking the level of the rapidly flowing water. Some such expedient was called for in the case of a very porous specimen by the fact that checking the flow of a rapid current was found to interfere materially with the constancy of results.

(Concluded next week.)

Standard Contour Lines for Vertical Plane Couplers, and the Lateral Displacement of Couplers on Curves.

At the last meeting of the Western Railway Club, a paper was read by Mr. D. L. BARNES on Vertical Plane Couplers and Automatic Air Brakes. He showed by the diagrams, Figs. 1 to 6, the necessity of close adherence to the standard contour lines for vertical plane couplers adopted by the Master Car-Builders' Association. Figs. 1 to 6 show the practical working of one of the recently proposed contours, which, while it couples readily with a drawhead made on the M. C. B. lines, is yet shown to have many serious defects when so coupled. For instance, in Figs. 3 and 4, where a coupler with the proposed contour is coupled with the M. C. B. standard, the two couplers can rotate to the right 17½°, but to the left they can only rotate 9°. Thus cars joined by these couplers would pass around a curve to the right when they would not pass one to the left.

When the couplers become worn, as shown in Fig. 5, where a worn coupler of the proposed contour is joined with a worn M. C. B. coupler, only one guard arm remains in contact, and hence has to take all of the wear. As the guard arm is a part of the coupling which wears very rapidly, it is important that this wear should be equally distributed to both arms.

Concerning the ultimate strength of couplers, Mr. BARNES showed that the position of the two heads with reference to each other is an important factor. In the position shown in Fig. 7 couplers have an average ultimate strength of about 80,000 lbs. As a matter of fact, however, couplers in service run in the position shown in Fig. 8, and Fig. 6 shows the position of two M. C. B. couplers after being worn a total of ¼ in. It will be seen that wear makes the knuckle thinner and also causes it to act as a wedge. Departure from the standard contour lines will make this wedging action worse, and necessitates scrapping the coupler when it is less worn. For gauging the wear of couplers, the point *J* on the end of the knuckle remains almost constant, and the line *G H* retains nearly its original position. These, therefore, should be taken as a base, and by a sliding gauge the wear of the points *C* and *F* can be determined.

In Figs. 9 to 12 the author showed the action of M. C. B. couplers joining cars of different lengths when passing around sharp curves. It is not the angularity which makes trouble but the different lateral displacements of the couplers, which reaches a maximum in Fig. 12, where is shown the couplers on a tender and on a baggage car, meeting on a 20° curve. The standard clearance of ⅝ in. on each side the draw bar in the stirrup is of course much too small to meet these extreme cases. Some of the stock car companies are now giving double this clearance; but even this is not enough, and the author suggests the allowance of two or three inches lateral motion, with light springs on each side the drawbar to keep it centered in making a coupling. One of the coupler manufacturers is soon to bring out a knuckle-joint draw-bar for use on tenders, whose short wheel-base makes lateral play most essential.

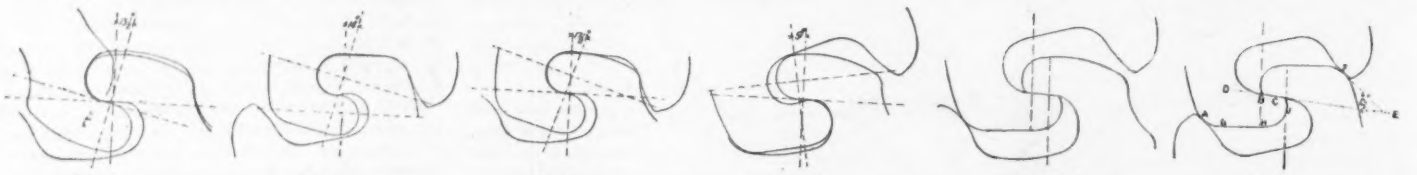


Fig. 1. Fig. 2. Fig. 3. Fig. 4. Fig. 5. Fig. 6.

Fig. 1 shows a recently proposed contour for M. C. B. couplers rotated to the maximum angle, 13½°. Fig. 2 shows the M. C. B. standard contour lines rotated to the maximum angle, 14°. Fig 3 shows a drawhead on the proposed lines coupled with one on the M. C. B. standard lines, and rotated to the right. Here the maximum angle is 17½° or 3½° more than the M. C B. standard. Fig. 4 shows the same couplers rotated to the left, where the maximum angle is only 9°, or 5° less than the M. C B. standard. Figs. 5 and 6 show that couplers built on different lines do not work satisfactorily when worn. Fig. 5 shows a worn M. C. B. drawhead coupled to a worn drawhead built on the proposed contour. It will be seen that only one guard arm is in contact; while in Fig. 6, which represents two worn couplers built on M. C. B. lines, both guard arms are in contact. Fig. 6 shows also the loss of strength on the M. C. B. coupler after a total wear of ¼ in. The point of bearing of the knuckle has been carried outward from B to C, and the leverage against the knuckle is increased. The knuckle also has become thinner, and the plane of bearing, D E, is at an angle with the line of stress instead of at right angles to it, as seen. The effect of this is to make a wedge of the knuckle, as shown by the dotted lines, the wedge having an angle of 37°.

EFFECT OF BAD CONTOUR LINES FOR M. C. B. COUPLERS.

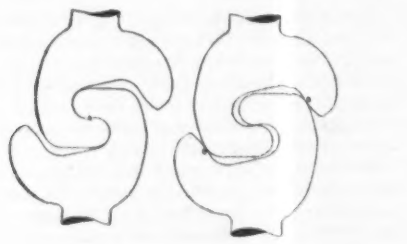


Fig. 7. Fig. 8.

Fig. 7 shows intended position of M. C. B. drawbars when coupled. Fig. 8 shows actual position in service.

THEORETICAL AND ACTUAL POSITION OF M. C. B. COUPLERS.

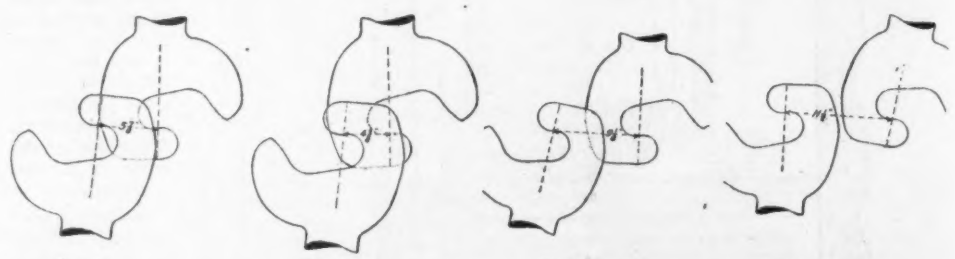


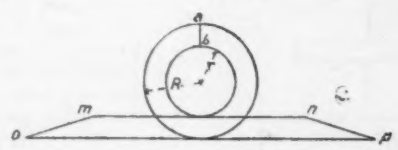
Fig. 9. Fig. 10. Fig. 11. Fig. 12.

Fig. 9 shows position of M. C. B. standard couplers on locomotive tender and on baggage car, meeting on a 10° curve; lateral displacement, 5⅞ ins. Fig. 10 shows position of M. C. B. couplers on ore car and on a long furniture car meeting on a 20° curve; lateral displacement, 4⅜ ins. Fig. 11 shows coupler on 34-ft. freight car and one on a baggage car, on a 20° curve; lateral displacement, 9⅛ ins. Fig. 12 shows couplers on locomotive tender and on baggage car, meeting on a 20° curve; lateral displacement, 11¼ ins.

LATERAL DISPLACEMENT OF M. C B. COUPLERS ATTACHED TO CARS OF DIFFERENT LENGTHS STANDING ON CURVES.

Measuring Belting.

The *Boston Journal of Commerce* recently gave the accompanying diagram illustrating the derivation of the usual rule for measuring belting, viz.: To the diameter of the roll in inches add the diameter of the inner coil or eye. Multiply this sum by the number



of coils in the roll, and this product by 0.1309. The final product is the length of the belting in feet.

The rule is easily deduced by the following transformations, *r* and *R* being in inches. If the roll is cut on the line *a b*, the belt will fall into a form *m, n, o, p* with a trapezoidal section.

$$L = \left(\frac{2\pi r + 2\pi R}{2}\right) n \text{ ins.} = \frac{\pi}{12}(r + R)\, n \text{ ft.} =$$

$$0.1309 \left(\frac{r + R}{2}\right) n \text{ ft.}$$

This rule, however, is only approximately true, for the belt is not arranged in the roll in the form of circular rings, but coiled into a nearly true archimedian spiral.

THE PURCHASE BY THE CITY OF BROOKLYN of the works of the Long Island Water Supply Co., has given rise to cries of jobbery. The company was chartered to supply the town of New Lots, which in 1886, was annexed to Brooklyn, and became the 26th ward of the city. By the terms of the act of annexation the mayor, comptroller and city auditor were authorized to purchase the plant of the water company. On Dec. 22, a contract was signed by the above officials and CYRUS E. STAPLES as agent for the company, transferring the works to the city upon the payment of the stipulated price on Dec. 30. The price agreed upon was $750,000 in cash or 3% city bonds, and in addition the assumption by the city of 6% mortgage bonds amounting to $500,000. It is said that the works now include 8 supply wells, a 3,000,000-gall. pumping plant, a 4,000,000-gall. reservoir and 51 miles of mains. There are 2,500 shares of stock having a par value of $100 each, for which it will be seen that the city was to pay $300 per share.

A TEMPORARY INJUNCTION TO PREVENT THE TRANSFER of the above named works to the city and an order to show cause why the injunction should not be made permanent, was granted on Dec. 27 by Justice EDGAR M. CULLEN as the result of a taxpayer's suit brought by Mr. WILLIAM ZIEGLER, a heavy taxpayer and real estate owner in the 26th ward. According to the affidavits of Mr. ZIEGLER and others, as published in the Brooklyn *Eagle*, the stock of the company is believed to be worth less than its face value, and the bulk of it is believed to have been purchased recently by Mr. CYRUS E. STAPLES for 70 cents on the dollar; and in addition to this it is stated that the company surreptitiously connected, some time ago, with the city water mains, and drew its supply from them instead of from its own supply wells and pumping stations. The act annexing New Lots provided that the

city of Brooklyn should not, during the life of the company's franchise, or prior to the purchase by the city of the company's works, lay any mains or supply any water in the annexed district. This provision, Mr. ZIEGLER claims, is unconstitutional and in view of this unconstitutionality and the large price paid for the company's works he claims that the purchase-contract includes a large consideration for the company's franchise. The plaintiff believes that the purchase of the works would be illegal and a waste of the city's funds, and therefore asks that the contract be annulled. The case will be heard on Jan. 5.

THE SERVIS TIE-PLATE for preventing the cutting of railway ties by the rail flanges, described in ENGINEERING NEWS, March 16, 1889, appears to be coming into extensive use, from information recently received. Tests of its efficiency as a brace chair have been made at the Illinois Steel Works under the direction of Capt. R. W. HUNT. A rail fastened to a seasoned white oak tie with 2 standard spikes required a pressure of 5,000 lbs. to spread the gauge ¼-in., while the tie-plate moved only ⅛-in., the inside spike lifting when the rail was subjected to a pressure of 11,230 lbs. A standard rail brace with 3 extra spikes required 17,400 lbs. to spread the gauge. In tests with cedar ties, made at Watertown, Mass., under the direction of the Ordnance Department, the following results were obtained: A rail fastened with 2 spikes only showed a resistance of 2,167 lbs., the Servis tie-plate with 2 spikes showed 7,910 lbs., while a rail brace with 3 extra spikes showed 9,200 lbs. The cedar ties with the Servis plate offered nearly 80 % more resistance than the 2 spikes in seasoned oak. The plate is made in two sizes, 3¾ ins. × 8 ins., costing 15 cts. per pair, and 6 ins. × 8 ins., costing 22½ cts. per pair. It is estimated that with 2,640 ties per mile, costing 30 cts. each, and 10 cts. each for labor of renewal, there will be a saving of $660 per mile by the use of the tie plates at 15 cts. per pair. The plates are sold by the Dunham Mfg. Co., of Boston, Mass. We have many times expressed our belief that tie-plates of some kind must necessarily come into extensive use before long.

A STREET-CLEANING SYNDICATE IN BALTIMORE, made up of a number of business men of that city, makes a formal proposition to perform all the duties of the street-cleaning department in a more effective manner than heretofore, for $175,000 per annum, for 5 years. This is $100,000 less than it cost the city in 1889. They offer satisfactory bonds, but stipulate that they are to be allowed all refuse matter collected. They would form a stock company and would expect some profit from their enterprise.

THE MEXICAN GULF RAILWAY, says a correspondent of *The Engineering and Mining Journal*, is laid with mahogany ties and the bridges and culverts are built of white marble. This reminds us of another Mexican railway, on the west coast, that has ties of ebony and is ballasted with silver ore—from the "dump" of an old reduction works near the line. This sounds magnificent, but there was little choice of material in either case; certainly not in the case of the ebony ties, which required boring for every spike-hole, and from which spikes could be extracted only with the greatest difficulty, if at all.

THE NEW RAPID TRANSIT COMMISSION, of New York, will shortly take up the work where it was dropped by the BELMONT Commission, last June. Among the many plans submitted to them is one by the American representative of Mr. GREATHEAD, the engineer of the Southwark tunnel under the Thames. This plan generally follows the lines suggested by Mr. HEMAN CLARK, several years ago, and proposes a tunnel located from 50 to 100 ft. below the general surface and the deepest foundations. This tunnel would be lighted by electricity, be well ventilated, and contain a four track railway, made accessible by shafts provided with elevators. Where Mr. CLARK proposed to go deep enough to construct a tunnel in the rock, Mr. GREATHEAD proposes a steel tube provided with a shield where the material demands this precaution. No details have as yet appeared.

COMPOUND LOCOMOTIVES of the two-cylinder type are being introduced on Irish railways. Those tried on the Belfast & Western Counties Ry. having proved successful, the Belfast & County Down Ry. Co. has decided to try similar engines, and an order has been given to Messrs. Beyer, Peacock & Co., of Manchester, England, to build them.

THE PORT ROYAL DRY-DOCK CONTRACT, referred to several times lately in this journal, was awarded on Dec. 22 to Mr. JUSTIN MCCARTHY, of Washington, D. C., for $418,915, provided he accepts the Navy Department's modifications of his plans.

THE PANAMA CANAL PROJECT has been revived to the extent of a new contract between Lieut. WYSE and the Colombian Government. The basis of this contract is that the company pays for lands taken on the Isthmus, the expense of the garrison, $2,000,000 in five annual installments, and $1,000,000 in privileged shares, and reorganizes and recommences work in 26 months.

A CONTROVERSY CONCERNING THE KEELY MOTOR has been more or less ventilated in the newspapers lately, but generally in a rather misleading way. The following are the actual facts in the case, furnished us from authoritative sources: Mrs. CLARA JESSOP MOORE, a wealthy lady of Philadelphia, has taken a great interest in Mr. KEELY'S experiments, not because of any monetary interest in the company, but because of her belief that Mr. KEELY'S work might prove to be of great scientific value. For some time she has personally furnished all the funds necessary for carrying on Mr. KEELY'S experiments and supporting him and his family. The stockholders of the Keely Motor Co., desire financial results first and care nothing for the scientific aspects of the case. They desire Mr. KEELY to continue to work away on his "commercial engine," which has thus far proved such an *ignis fatuus*, and abandon researches into the nature of his unknown force. Mrs. MOORE has made, therefore, the following proposition to the company: That they shall cease all interference with Mr. KEELY and permit him to pursue his experiments under the direction of Prof. HERTZ, of Bonn University, Germany, who is among the foremost of living physicists, Prof. FITZGERALD, of Trinity College, Dublin; Prof. BARKER, of the University of Pennsylvania, and other noted scientists whom Mrs. MOORE has interested in Mr. KEELY'S work. If they will do this until such time as Mr. KEELY'S work can be placed on a sound scientific basis, Mrs. MOORE agrees to furnish all funds necessary for the experiments.

It is greatly to be hoped that the managers of the Keely Motor Co. will have common sense enough to accept this munificent offer; for there is small hope of the commercial success of their company unless the experiments which Mr. KEELY now blindly performs are placed on a scientific and intelligible basis, provided this is possible.

THE CAUCA RAILWAY, says the *Panama Star and Herald*, is to be the first link in the Colombian section of the Pan-American railway of the future. A concession has been granted, says that journal, to Mr. JAMES L. CHERRY requiring him to immediately begin construction on the first section of the Cauca Railway, from Buenaventura to Cali, a distance of about 100 miles. This line is to be completed within 4 years. The second section will extend from Cali to Manizales, about 250 miles. The same concession gives Mr. CHERRY the preference right to contract for constructing lines either to the Atrato River or the Gulf of Darien, to the north, or to the frontiers of Ecuador and the Amazon and Patumayo rivers on the south. The Colombian government guarantees 5% per annum on an outlay of $38,000, gold, per kilometre for a period of 18 years, for the first section, and 4½% on a similar basis for the second section. Mr. CHERRY is also granted on each side of the constructed road a zone 40 kilometres wide for colonization purposes, and also to certain preference claims on mineral deposits. The financial agents in this country are Messrs. Ladenburg, Thalmann & Co., of New York.

STREET CLEANING IN NEW YORK is to cost $1,584,250 for 1891. This is $329,250 more than was appropriated for 1890, though it is $203,000 less than Commissioner BEATTIE asked for. He wants $200,000 to spend for additional carts and horses, and says he could save to the city $125,000 by having a sufficient plant. In this connection, the Senate Committee, now investigating the methods of the New York Street Cleaning Department, show by statistics that the appropriations have been gradually increasing from $1,010,000, in 1882, to the present figures. The amount received from the sale of garbage and selected sweepings was $54,709.39 in 1890; while it was only $9,360.07 in 1882.

A MODEL OF THE "MULTIPLE DISPATCH RAILWAY" proposed for the Columbian Exposition, at Chicago, and described in our issue of Dec. 13, is on exhibition in the Rookery Building, Chicago. It is made to a scale of 1 in 36, and contains 116 cars running by electricity on a track representing 1,044 ft. in circumference. The minimum radius of curvature is 108 ft., and the total curvature to complete the circuit by introducing several curves is 458 deg. 28 min. The curves are reversed without tangents. There is a grade of 320 ft. per mile on one side of the model. The motive power will be transmitted by cable power or electricity; if the latter is adopted, it is proposed to supply it through circuits from dynamos to motors attached to the axles, at equidistant points on the circuits. It is stated that careful estimates show that about 1,000 HP. will be required to run a train on a circuit three miles long, with cars of the weight designed for the Exposition line. As regards accidents, it is not unreasonably claimed that at the low speed at which it is proposed to run the train, there are not likely to be derailments, heated journals or troubles with the bearings and rolling stock, and that even should such accidents occur no serious results would follow. As regards detentions from having to stop the whole endless train to correct minor troubles, it would seem as if there might be more cause for fear.

THE CHICAGO DRAINAGE COMMISSION has made public the report of Mr. L. E. COOLEY, late Chief Engineer. Mr. COOLEY favors a policy which looks ultimately to deep water from Chicago to the Gulf. He recommends the abandonment of a lake front harbor for commercial purposes, and the utilization of a filled-in lake front for building sites. He would transfer the docks to the Chicago and Desplaines rivers, where unlimited dockage could be secured. In referring to the commercial importance of the project, Mr. COOLEY said that with deep water from the Hudson to the Gulf via the lakes, a vessel making the circuit would touch at cities containing 30% of the urban population of the country.

A STATE BOARD OF PUBLIC WORKS is provided for in the codification and revision of the State law of Kansas, as just submitted by a Senate committee. This board would consist of three persons appointed by the governor, with the advice and consent of the Senate. Two of the members of this board are to be "experienced mechanics and builders." They hold office for four years, give a bond and are under oath. It will be their duty "to superintend" the erection of all public buildings, the construction of systems of sewerage, steam heating, electric lighting, water works, etc. All plans for public works must be submitted for their approval, and they must appoint a skillful architect, who shall devote his whole time to the State, as an assistant. The new law also provides for the letting of public contracts to the lowest bidder, appropriation and condemnation of land, etc. The bill containing these provisions is framed, but has yet to pass the Legislature.

PITTSBURG'S IRON OUTPUT, for 1890, was greater than for any previous year, notwithstanding the later restriction of production due to the curtailment of the supply of natural gas. Statistics of Dec. 30 show that 1,009,500 tons of iron and steel were turned out, of which Carnegie & Co. furnished 550,000 tons. In addition to this there were 203,800 tons of muck iron. This aggregate is the output of 12 manufacturing firms.

MITIS METAL has been found, by Prof. SILVANUS THOMPSON, to be far superior to ordinary cast iron, and not much inferior to wrought iron, for electromagnets. Its great advantage for the cheaper forms of dynamos and motors is that it can be easily cast to the form required, and the expensive forgings avoided that are now necessary with wrought iron.

THE ENGLISH CHANNEL TUNNEL CO., at a meeting held Dec. 18, reported that the experimental tunnel was in excellent order. The gray chalk was now dry and hard, resembling firestone, and the perco-

lation of water was inconsiderable. This trial tunnel is 2,300 yds. long. In the search for coal measures, now going on, they had found one 3 ft. 6 in. seam. They have also found traces of petroleum and bituminous shale suitable for the production of mineral oil.

A 230-FT. DRAWBRIDGE WAS LATELY TRANSFERRED to a new center pier in 9 hours on the Chicago & Northwestern Ry., at Milwaukee. The road is being double tracked and a new bridge is to be built, and meanwhile traffic is to be transferred to a temporary line 175 ft. distant. The span weighed 210 tons, says a Milwaukee exchange, and was transferred to trestles resting upon four 60-ton screws, two under each end. A tug then hauled these scows to the new center pier, and the span was lowered upon it by the hydraulic jacks. Work commenced at 7:30 A. M., and the bridge was again swung at 4:30 P. M. The transfer was made under the direction of Assistant Chief Engineer E. C. CARTER, with 60 men.

THE BAXTER CAR MOTOR was recently tested at Baltimore, Md., with, it is reported, quite satisfactory results. The novel feature of the motor is the very low speed of the armature, only 100 to 350 revolutions a minute, which requires the use of but few gears, and hence lessens materially the cost of repairs. At present the worst feature of electric car machinery is the gearing used, and any system that will actually reduce their number without introducing other difficulties is sure of a welcome among street railway men. The experimental car is fitted with two 24-HP. motors, each 18 × 24 × 11 ins., weighing 1,500 lbs., and so arranged that the brush holders can be reached from a trap door inside the car. The average speed maintained was about 7 miles an hour with from 50 to 60 persons on board.

THE CONSOLIDATED CAR-HEATING CO. calls our attention to the fact that the Pullman car "Matterborn," cut in two in a recent accident at Jacksonville Junction, was not heated by steam but by an ordinary Baker heater. It was, therefore, impossible that Mr. WM. B. KNIGHT, whose lamented death was chronicled in our issue of Dec. 13, should be scalded by steam from the heating pipes, as might be inferred from some expressions in the record in which we gave of the occurrence, the information for which was obtained chiefly from the press dispatches.

A DRAINAGE SCHEME FOR MELBOURNE, proposed by JAMES MANSERGH, engineer for the government of Victoria, would cover an area of 134 sq. miles, and is planned for a present population of 430,000 and an ultimate population of 1,700,000. The separate system is recommended with a disposal by soil filtration. The estimated ultimate cost is nearly $30,000,000.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Baltimore & Ohio—The grading on the Akron & Chicago Junction R. R. from Chicago Junction to Warwick, O., 60 miles, has been completed and 30 miles of track has been laid. It is expected to finish the tracklaying and ballasting during January. Work on the 18-mile section from Warwick to Akron, O., will begin at once. The Akron & Chicago Junction R. R., is an extension of the B. & O. R. R. from Akron to Chicago Junction, O., 78 miles. At Akron it will connect with the Pittsburg Cleveland & Toledo, R. R., owned by the B. & O. R. R. Co.

Dunderberg Spiral.—Work on the gravity railway at Mt. Dunderberg, in New York State, which has been delayed for some time will be resumed at once. A full description of this enterprise was given in our issue of Dec. 21, 1889.

New York & New England.—It is stated that this company will apply to the Connecticut State Legislature for power to build the necessary connecting links to complete a line along the east bank of the Thames River from Willimantic to New London.

Lancaster, Oxford & Southern.—S. C. Slaymaker, of Lancaster, Pa., chief engineer, writes as follows:

This railway is projected to run from the southern terminus of the Lancaster & Quarryville, R. R., 16 miles south of Lancaster, Pa., south 9 miles to White Rock, on the Oxford & Peach Bottom R. R. From White Rock to Oxford, Md., the latter road will be changed to standard gauge. From Oxford to a connection with the Baltimore & Ohio R. R. 14 miles, a new line will be built. About 7 miles of the line will be in Maryland and the balance in Pennsylvania. The work will be moderate. The line has been located, and contracts for construction will be let next spring. The principal business will be in agricultural produce and the products from the mills along the route. Walter M. Franklin, of Lancaster, Pa., is President.

Projects and Surveys.

Stoneham & Middlesex.—A project is on foot to build a railway from Stoneham to Middlesex Falls, Mass., 3 miles.

Reading & Southwestern.—The preliminary surveys for the new railway from Reading to Friedensburg, Pa., are about completed. The distance is 10½ miles, and the road will run through the rich Oley Valley, which is penetrated by no other line. There will be 5 stations. The total cost of construction will be about $70,000. The new road will connect with the Philadelphia & Reading R. R. at Klapperthal station.

Saltsbury & West Lebanon.—Surveys have been completed for a railway from Saltsbury to West Lebanon, Pa., 10 miles, penetrating the Eldersridge and West Lebanon coal fields.

SOUTHERN.—Existing Roads.

South Brunswick Terminal.—It is stated that this Georgia railway will be put in operation soon and that an extension will be built. The road was built in 1889, but owing to financial difficulties has never been put in operation.

Farmville & Powhatan.—Surveys are being made for a branch of this Virginia railway to connect with the Norfolk & Western R. R. in Appomattox Co.

Projects and Surveys.

Kanawha & Elk River.—Chartered in West Virginia to build a railway from the mouth of Kelly's Creek to Sutton, Braxton County. David Ward, of Detroit, Mich., is interested.

Berryville & Summit Point.—Incorporated in West Virginia to build a railway from Jefferson Point, W. Va., to Berryville, Va. Among the incorporators are: C. P. Wilson, and A. P. Thompson, of Summit Point, W. Va.

Georgia.—Bills have been introduced into the Georgia State Legislature to incorporate the Etna R. R. Co., and the Macon & Indian Springs R. R. Co.

Charleston, Batesbury & Western.—This company has applied for a charter to construct a railway in South Carolina.

NORTHWEST.—Existing Roads.

Winona & Southwestern.—Tracklaying has been completed from Utica to Spring Valley, Minn., 46 miles, since Jan. 1, 1890. The grading is nearly completed for the extension from Spring Valley to Osago, Ia., 37 miles.

Projects and Surveys.

Midland Pacific.—The surveys for this road have been completed through South Dakota to the Wyoming State line. The projectors hope to commence construction early in the spring.

Bloomington & Lancaster.—It is stated that the citizens of the village of Bloomington, Wis., have purchased the right of way for a railroad from that place to the city of Lancaster, a distance of about 14 miles. They propose to donate this to the Chicago & Northwestern R. R. Co., which expects to take up its narrow gauge tracks from Fennimore to Woodman, and replace the same with a standard gauge. The narrow gauge will be laid between Lancaster and Bloomington.

SOUTHWEST. Existing Roads.

Fort Wayne, Terre Haute & Southern.—A press dispatch says:

A short time ago, the Fort Wayne, Terre Haute & Southwestern R. R. Co., newly incorporated, placed 500 men and 200 teams at work between Carbon and Mansfield, Ind., to build a track connecting the two towns, a distance of 8 miles. The line has been completed. It will be extended to Bainbridge at once, because of a large contract for hauling stone from the Mansfield quarries. It will then be built to Brazil, thus affording a new route to the Chicago market.

St. Louis & Eastern.—Wm. E. Gay, of St. Louis, Mo., president, writes us that 12 miles of this road have been completed from Venice, Ill., to Glen Carbon coal mines. Ten miles of this track is operated jointly with the Jacksonville & Southwestern R. R. The road will ultimately be extended to Muncie, Ill., 25 miles from East St. Louis. The work was moderate; maximum grade 40 ft. per mile and maximum curve 4°. The road will do only a freight business at present.

Chicago, Rock Island & Pacific.—It is announced that work will soon be resumed on the extension from Minco, Ind. Ter., south. Engineers are surveying the route.

Cape Girardeau & Southwestern.—At a recent meeting it was voted to increase the capital stock of this road to $12,000,000. The proceeds of the new stock are to be used in extending the road from Hunter, Mo., to Monmouth Springs, Ark.

Projects and Surveys.

Fort Gibson, Tahlequah & Great Northern.—Chartered in Arkansas to build a railway from a point on the line of the St. Louis & San Francisco R. R., in Benton Co., west to Bentonville; thence south through Siloam Springs to Tahlequah, Indian Territory; thence west to Fort Gibson, situated on Grand River, near where that river empties into the Arkansas River. The length of the road in Arkansas is 35 miles and in the Indian Nation about 50 miles, making the total length about 90 miles. The Directors of the company are J. E. Crane, E. T. Smith, W. W. Brown, of Siloam Springs; W. R. Freker, of Rogers, and E. P. Watson, of Bentonville.

ROCKY MT. AND PACIFIC.—Existing Roads.

Port Townsend Southern.—It is stated that work will be resumed on this Washington railway in the spring. About 20 miles of the line from Port Townsend, Wash., south are now completed. From Olympia, Wash., north to Lake City considerable grading has been done, and the section from Lake City to the end of track south of Port Townsend has been surveyed.

Projects and Surveys.

Union Terminal & Warehouse Co.—Chartered in Colorado to construct stations, shops, roundhouses and other terminal facilities at Denver, Col., for the use of railway, express and other transportation companies doing business in the city.

FOREIGN.

Bolivia.—A press dispatch says:

The Bureau of the America Republics has information that Dr. Antonio Quijarro, representing a syndicate of English and German capitalists, has submitted to the Government of Bolivia a plan for a railway system for that republic. The Quijarro plan proposes three lines of road, one from Sucre to the Argentine frontier to connect with the system of the latter republic; another from Sucre to the mines of Potosi, and a third from La Paza, the capital, across the Bolivian provinces to the navigable waters of the Paraguay River, which will give commerce over that line unobstructed water transportation to the sea. The Government of Bolivia considers the plan favorably and will doubtless give a liberal subsidy to its projectors to aid its construction.

Colombia.—A press dispatch says:

Information has been received at the Bureau of American Republics that the Government of Colombia has signed a contract with Mr. J. L. Cherry, of Milwaukee, Wis., for the completion of the Cauca Valley Ry. from Buena Ventura, the chief port of Colombia, from the Pacific Ocean to the cities of Calli and Nanizales, with the privilege of continuing the road to the Gulf of Darien on the north and the frontier of Ecuador on the south, and eastward to the navigable waters of the Amazon River. This road, when completed, will give a portion of Columbia that is very rich in both agricultural and mineral resources access to tide water. The government guarantees interest of 5% gold for 18 years upon an expenditure of $38,000 gold per mile, and exclusive privilege for 70 years of operating a railway within 24 miles on either side of the route surveyed and accepted, the title to all gold and other mines that may be discovered within this 24-mile limit, and freedom from all duties and taxes for 10 years.

CITY TRANSIT.

Cable Railway.—*Oakland, Cal.*—Ex Gov. H. G. Blasdel has filed a petition with the City Clerk for a cable, horse or electric railway.

Electric Railway.—*Boston, Mass.*—The Directors of the West End Street Ry. have been authorized to petition the Railroad Commissioners for leave to increase the capital stock by $4,500,000, divided into 90,000 shares of common stock, to enable the company to pay for construction and increase of property, and especially the expense of perfecting the electric system.

Holyoke, Mass.—The stockholders of the Street Railway Co. have voted to increase the capital stock from $50,000 to $150,000 for the purpose of equipping the various lines with electricity in the spring.

Trenton, N. J.—The Trenton City Council has, it is said, passed an ordinance giving both the local horse car lines the right to use electricity as a motor. The overhead system will probably be adopted, with poles on the sidewalk.

Washington, Pa.—The Washington Electric Street Ry., capital stock $60,000, now has about 2 miles of track laid and proposes to put down as much more. Wilson & Smith write that the power is furnished by the Washington Light & Power Co., using the Westinghouse system.

Washington, D. C.—C. O. Mailloux, the electric engineer in charge of the Metropolitan R. R. plant, informs us that the equipment will consists of two power plants, one for each of the lines operated by the company. The buildings for the main line will be 3 in number, an office building 122 × 85 ft., 2 stories high, an engine and dynamo building, 80 × 60 ft., and a boiler house, 40 × 60 ft. There will be 3 tandem compound non-condensing Corliss engines of 200 HP. each, driving the main charging dynamos.

St. Louis, Mo.—A press dispatch states that the Adams Electric Railway Co. proposes to bring suits for alleged infringements against all other electric railway companies.

Leadville, Colo.—An electric railway company has been formed here for the purpose of constructing a 6-mile line. Col. R. G. Goodell can give further information.

Dallas, Tex.—A franchise for another electric street railway has been granted, the line to be about 4 miles long.

Raleigh, N. C.—The Edison Electric Co. has been awarded the contract for converting the street railway into an electric one.

Fort Worth, Tex.—J. C Ryan has, it is stated, arranged for the construction of an electric line to Prospect Heights.

Lincoln, Neb.—The Street Railway Co.'s system has been enlarged by the purchase of new lines, so that the management now controls about 24 miles of track, all of which will be soon operated by electricity, it is reported.

Grand Rapids, Mich.—The system of lines in this city, embracing some 40 miles of track, will probably be

operated electrically. Experts have been requested to examine the lines and estimate the cost of a plant.

New Companies.—Salamanca, N. Y., Surface Electric Ry.; capital stock, $100,000; incorporators: H. Ansley, T. A. Heller, E. B. Vreeland and others. Milwaukee, Wis., Street Ry.; capital stock, $1,000,000; incorporators: F. G. Bigelow, H. C. Payne, G. H. Noyes. San Diego, Cal., Electric Transit & Power Co.; capital stock, $1,000,000; incorporators: G. S. Havermale, J. C. Fisher, D. D. Dare and others.

HIGHWAYS.

Pennsylvania.—The Perryville Park Road Co., of Pittsburgh, will rebuild about 1¼ miles of road next season, and Mr. Davidson, the secretary, has advertised for 60,000 ft. of 3-in. plank for this purpose. The work requires 40,000 ft. to the mile.

New Jersey.—The directors of the Woodbury & Gloucester Turnpike Co., at Woodbury, have decided to build a telford road from Red Bank Ave. to Gloucester. This improvement to the turnpike, which at some seasons is almost impassable, will be of great value to the farmers who convey their produce to Philadelphia markets over this road. The distance covered will be about 4 miles and will cost about $40,000. The work will be begun early in the spring. A case in reference to the use of trap rock or mine stone in paving a public highway in Bergen County, brought before Chancellor McGill, has been decided by that official. It was claimed that the contract called for trap rock paving on certain roads, and it was asserted that sandstone was to be used from the Schuyler mines. The mines also yielded a species of trap rock substantially as good as that called for in the contract. It was decided that the latter stone might be used, but that the sandstone could not be used, for its use would be a fraud upon the taxpayers of the township.

BRIDGES, TUNNELS AND CANALS.

Bridges.—***Burton, Vt.***—The Passumpsic R. R. will build a stone arch bridge at this place.

Cleveland, O.—Plans are being prepared for bridges over the Cuyahoga River at Columbus and Center streets. Both bridges will have draw spans.

Fort White, Fla.—Bridges are to be built across the Schetucknee and Santa Fe rivers near this place.

WATER-WORKS.

NEW ENGLAND.

Gouldsboro and Grindstone Neck, Me.—The following is from C. P. Simpson, Sullivan:

The Gouldsboro Land Improvement Co. have made a survey of a water supply from Birch Harbor Pond for Grindstone Neck, where property is owned by the company. The supply will probably be by gravity and pumping to reservoir or stand-pipe, with 2½ miles of mains. The works will be built in the spring.

Sorrento, Me.—A survey has been made for a permanent supply main to be put in by the present company next summer. C. P. Simpson, Sullivan, is Secretary.

Meriden, N. H.—A. F. Spaulding informs us that the works of the Meriden Water Co. are half completed.

The Weirs, N. H.—The new works have been tested.

Springfield, Mass.—An abstract from the report of the Water Commissioners for the year ending Dec. 10 appears in the Springfield *Republican* of Dec. 30. Good progress is being made on the Ludlow reservoir improvements. It is hoped that the work will be finished early in the spring.

MIDDLE.

Brooklyn, N. Y.—An injunction has been brought to prevent final action by the city in the purchase of the works of the Long Island Water Supply Co. A note elsewhere in this issue states the particulars.

SOUTHERN.

Statesville, N. C.—D. A. Miller, Mayor, has sent the following:

The franchise granted a year ago has lapsed, and bids for a new franchise will be received until Feb. 1. From 40 to 50 hydrants are wanted, and a 30 to 40 years franchise and fair hydrant rental is offered.

Wilson, N. C.—It is reported that $60,000 of water works bonds will be issued by the town. Address, George D. Green.

Atlanta, Ga.—A bill has been introduced in the legislature providing $25,000 for the construction of water-works and other improvements at the State Deaf and Dumb Asylum.

Fort Valley, Ga.—A bill authorizing the town to issue water-works bonds has passed the Legislature. A popular vote for acceptance will be taken in February. The town has no debt.

Bay St. Louis, Miss.—It is reported that the Gulf Coast Ice & Manufacturing Co. will put in water-works here.

Greenville, Miss.—It is reported that M. Pulbin, Chicago, Ill., has offered to complete the works here. The city has contracted successively with two companies since 1887 (see the MANUAL OF AMERICAN WATER-WORKS for 1889-90), the last being the Delta Water-Works, Sewerage & Light Co.

Greenwood, Miss.—R. M. Coyle, Mayor, informs us that the Council has taken no steps toward works.

Vicksburg, Miss.—It is reported that the mains of the Vicksburg Water Supply Co. will be extended.

Knoxville, Tenn.—According to the Knoxville *Journal* the majority of the stock of the Knoxville Water Co. has been sold to Boston parties who will, provided necessary arrangements can be made with the city, greatly improve and enlarge the works. Among the proposed improvements are: The removal of the pumping station to a point above the present sewerage outlet, new pumps, larger distributing mains and more hydrants.

Hickman, Ky.—George Warner informs us that a proposition looking to water-works is under consideration, but nothing definite has been done.

McMinnville, Tenn.—It is reported that an Eastern syndicate, represented by Ingersoll & Peyton, Knoxville, have made a proposition to the city regarding the construction of works.

Winchester, Ky.—F. P. Pendleton has sent the following:

Works are being built by Wheeler & Parks, Boston, Mass., under a franchise. There will be 10 miles of pipe and 72 hydrants. The supply will be pumped to a stand-pipe. The principal contracts, at least, have been let.

NORTH CENTRAL.

Coshocton, O.—Dunham & Paine, New York, Engineers for the new city works, have sent the following:

The works will be put in operation in February. The contracts have all been let. The supply is pumped to a reservoir. There will be 8½ miles of mains, and 90 hydrants.

Imlay City, Mich.—John Robinson informs us that the city works will be completed about Jan. 15. G. C. Morgan, Chicago, is contractor. Population, 1,300.

Milwaukee, Wis.—The crib connected with the new water supply tunnel and intake has been successfully placed.

NORTHWESTERN.

Sioux City, Ia.—The contract for works for temporary supply has not been awarded as yet. At last accounts it was proposed to receive bids until Jan. 13 for a driven well system.

Ponca, Neb.—A. E. Kingsbury, City Clerk, has sent the following:

The town has voted $10,000 of 6% 5-20 water-works bonds. Contracts will be let about Feb. 1. The supply will be pumped. William Lister is Mayor, and S. B. Stough will be Engineer.

SOUTHWESTERN.

Uvalde, Tex.—W. W. Collier, one of the incorporators of the company, has sent the following:

The Uvalde Water Supply & Power Co. propose to let contracts for works March 1, next. The supply will be pumped from the Leona River to a stand-pipe. The works are estimated to cost $19,000. The town has not yet granted the company a franchise but it is expected that it will do so on Jan. 7. No capital has been secured. The city will be asked to guarantee the interest on the company's bonds, and from the proceeds of the bonds the works will be built. Population, 2,500.

Trinidad, Col.—An attempt is being made by the Trinidad Water Co., and some of the citizens, to prevent the construction of an independent water-works system by the city. The case has been taken to a Denver court, and a temporary injunction has been agreed to. J. G. Northcutt is City Attorney.

PACIFIC.

Port Townsend, Wash.—An effort is being made to carry forward the proposed works of the Mount Olympus Water Co. The course of supply is the Quilcene River, some 18 miles distant.

Vancouver, Wash.—The Vancouver Water Co., recently brought action against the city to prevent it from granting a water-works franchise to the Columbia Improvement Co. The Superior Court has refused a permanent injunction, holding that the exclusive franchise granted the Vancouver Water Co. some 20 years ago was unconstitutional and void, as being a special privilege.

Independence, Ore.—N. E. Gilmore, President of the Independence Water Co., informs us that the company proposes to enlarge their works throughout during the coming spring.

Woodburn, Ore.—D. L. Remington & Son has sent the following:

The town has granted the above firm a 50-years' franchise, and works will be in operation in March. The firm makes its pipes and hydrants at its iron works. Population, 800.

CANADA.

Galt, Ont.—The following is from Willis Chipman, of Toronto, Engineer for the works:

Construction of works to be owned by the town has just been started; estimated cost, $105,000. All the contracts, save for boilers and pipe, have been let. The supply will be pumped from springs to a stand-pipe. Population, 7,000.

Gananoque, Ont.—Willis Chipman, of Toronto, Engineer for the works, has sent the following:

A fire protection system to cost $18,000 is being built by the town. Garson & Parser, St. Catherines, are the contractors. The material has not been bought. Water will be pumped from the Gananoque River directly to the mains. There will be 2 miles of cast-iron pipe, 22 hydrants and 9 valves. Population, 4,000.

Markham, Ont.—The following is from John Galt, of Toronto, Engineer for the works:

The town is building a small water-works plant. All the contracts have been let. Water will be pumped from springs to a tank, and there will be 1½ miles of mains. Population, 1,000.

North Toronto, Ont.—W. J. Douglas, Clerk, has sent the following:

The water-works question is as yet indefinite. The town solicitor will draw up a by-law regarding water-works, which will at some future time be submitted to the people.

Pentanguishene, Ont.—The following is from John Galt, of Toronto, engineer of the works:

Works owned by the town were put in operation Dec. 1. Water is pumped from springs to a steel tank. There are 3½ miles of mains. Population, 2,500.

New Westminster, B. C.—The following is from Arthur Hill, engineer:

The city is building works which will be put in operation Oct. 15, 1891. The principal contracts has been let. The supply will be by gravity from Coquitlam Lake. There will be 1½ miles of 22-in. and 15 miles of 14 in supply mains; also 20 miles of distributing mains. The estimated cost is $380,000, and the population is about 8,000.

FOREIGN.

Guadalajara, Mexico.—In *The Mexican Financier*, of Dec. 6, C. H. M. Blake, C. E., points out the pressing need of sewerage and water-works in Guadalajara. This city has most favorable topographical conditions for drainage into the San Juan de Dios river. The mean annual temperature is 68° F., with 86° as an annual maximum, and 50° as a minimum. The alarming death rate of 38.4 per 1,000, in a population of 90,000, shows the great need of sanitary improvement. Mr. BLAKE recommends the separate system of sewers as best adapted to the local conditions.

ARTESIAN WELLS.

Salem, Ore.—The Salem Water Co. is sinking a 3-in. experimental artesian well in the water-works crib in the Willamette River.

IRRIGATION.

Erie, Col.—The Butte Irrigating & Reservoir Co. has been organized with George Zimmerman as president, Max Greenfield as secretary and William Angove as treasurer. The company is said to have 500 shares of stock with a par value of $100, each share carrying with it a right to 100 miner's inches of water. A preliminary survey has been made, and sites for four reservoirs have been located. The ditch will start from Boulder Creek, about 6 miles below Boulder.

Rincon, N. M.—The Rio Grande Land & Irrigation Co. has been incorporated by W. W. H. Llewellyn, E. C. Wade and others. The capital stock is $50,000. A canal about 20 miles long is projected, which will take water from the east side of the Rio Grande River in Sierra Co.; township 16 south, range 4 west. From this point the canal would extend south into Doña Aña Co., crossing the Atchison, Topeka & Santa Fé R. R., about three miles west of Rincon Station.

Corning, Cal.—The Corning Irrigation Co. proposes to irrigate a large section of land in Tehama Co. H. Wilson and George Hoag are interested. The capital stock of the company is $32,000.

San Bernardino, Cal.—A press dispatch from this city states:

The Bear Valley Irrigation Co. has been incorporated with a capital stock of $4,000,000. $1,000,000 of which is preferred stock and $3,000,000 common stock. This company buys out the Bear Valley reservoir property and also the Alessandro tract of 210,000 acres, which is to be irrigated by Bear Valley reservoir water. The sum of $2,400,000 of common stock of the new company is used to buy these properties, and the remainder of the common stock and the preferred stock will be sold to raise the funds to build the new Bear Valley dam, at a cost of $750,000, and also to convey water to the Perris and Alessandro irrigating districts, comprising 510,000 acres of fruit lands.

Another dispatch states:

The Alessandro Development Co. has let a contract for laying 40 miles of vitrified pipe to distribute irrigation water to each 10-acre claim in the Alessandro tract. The contract is made with the Los Angeles, South Riverside and Elsinore pipe factories. This is the first installment of about 300 miles of pipe to be laid in the Alessandro irrigation district. The Alessandro Co. will commence digging trench pipe lines next week with a machine that will dig a mile a day.—The Riverside Trust Co. has just let a contract to have 50 more artesian wells sunk in San Bernardino Valley. The Alessandro Co. has sold 8,350 acres of land since Oct. 15 for $556,000, to nearly 400 purchasers.

SEWERAGE AND MUNICIPAL.

Sewers.—***Springfield, Mass.***—The sewer department reports that 1,355 ft. of brick and 13,938 ft. of salt glazed sewer pipe have been laid during the past year, and 80 flush gates have been set. All reconstructed sewers and repairs on sewers with bad foundations have been laid with vitrified Akron pipe on a concrete base.

Rochester, N. Y.—The plans for the proposed east side trunk sewer have been submitted to Mr. Samuel M. Gray for approval.

Newark, N. J.—There is considerable opposition to a general assessment of the whole city for the cost of the intercepting sewer.

Washington, Pa.—A considerable amount of sewerage work is to be carried out on the Waring system. Wilson & Smith are the engineers in charge of the work.

Macon, Ga.—The Legislature has passed a bill authorizing the city to issue bonds for $210,000 for sewerage and drainage.

Savannah, Ga.—Alderman Falligant has presented a report upon and an estimate of the cost of his proposed system of house drainage.

Cicero, Ill.—The special committee appointed to confer with the drainage commission of Chicago reported at a

recent meeting that they had consulted the engineer of said commission, and in his opinion the town of Cicero was perfectly safe in carrying out the plan of drainage and sewerage as prepared by Mr. Alvord, the town engineer. The report was adopted.

Omaha, Neb.—The Indian Creek sewer ditch, one of the most important improvements in the city's sewerage system, has been completed. It has been constructed under the supervision of Mr. Tostevin, city engineer.

Los Angeles, Cal.—There is a controversy between the Mayor and some of the city officials and the sewer pipe companies over the price of sewer pipe.

West Toronto Junction, Ont.—A report on the sewerage has been submitted to the Committee on Sewerage by Mr. Biggs, the engineer. The work will involve the expenditure of $250,000.

Streets.—*Providence, R. I.*—A tar concrete pavement is to be laid on the sidewalks of Melrose St.

Knoxville, Tenn.—The city will apply to the legislature for power to issue $500,000 in bonds for street paving bridges, sewers and other public improvements.

Houston, Tex.—The city engineer has prepared specifications for paving, sidewalks, etc., which will be adopted in all future work.

Gas.—*Chicago, Ill.*—An ordinance has been passed granting a franchise to the Economic Gas Trust Co. The company is to have 12 miles of pipe laid and in operation within 2 years. The city has the right to purchase and operate the works after 15 years. The price of the gas is not to exceed 60 cts. per 1,000 cu. ft.

ELECTRICAL.

Electric Light.—New plants or additions are proposed at Grafton, W. Va., address the Electric Light, Heat & Power Co.; Clifton Forge, Va., address G. Swarm; Newberry, S. C., address the mayor; Dayton, Tenn., address the mayor; Athens, Tenn., address the Athens Woolen Mill; Little Rock, Ark., address the mayor; Minera, Wells, Tex., address the mayor; Corpus Christi, Tex., address the Electric Light Co.

Washington, Pa.—The town recently awarded a contract for 47 arc lights of 2,000 c. p. to the Washington Electric Light & Power Co., at $85 per lamp-year on all-night running.

Baltimore, Md.—S. D. Warfield, of the Warfield Mfg. Co., recently placed an interesting lighting plant in a portion of the Belt Line tunnels. C. & C. dynamos, driven by an automatic Warfield engine, supply a current at 110 volts, which is transformed to supply 2,000 c. p. arc lights. Such a system offers great advantages in tunnel driving on account of the low tension current employed.

Wilson, N. C.—There is some talk of the city issuing $15,000 of bonds for an electric light plant.

Knoxville, Tenn.—The Knoxville Schuyler Electric Light Co. has, it is stated, issued $20,000 of bonds for the purpose of enlarging its electric light plant.

Memphis, Tenn.—A. W. Allison, B. M. Statton, W. H. Bates, and others, are reported as about to install a power and lighting plant.

Cleveland, O.—The Board of Public Works recently adopted a resolution authorizing the Clerk to call for bids for electric and gas lighting of the streets.

Denver, Colo.—The estimated cost of an electric light plant for the city is $174,000, and the monthly running expenses are fixed at $1,255, or $27,060 a year. The city now pays annually $194.40 each for 240 arc lights, and $26 each for 1,200 incandescent lamps, a total of $77,856. If interest on the plant is calculated at 6%, the city would save something like $40,356 by owning its apparatus, provided the estimate is correct.

Alamo, Tex.—An ordinance was recently introduced in the City Council creating the office of City Electrician at a salary of $2,000. He will be required to look after the electric motor, light, telephone and fire alarm systems.

Woodburn, Ore.—D. L. Remington & Sons, owners of the water-works here, report that they will shortly put in an electric light plant.

Silverton, Ore.—A $3,000 arc and incandescent light plant will probably be installed here immediately. The town will, it is said, use 16 arc lights and private parties desire quite a number.

Electric Power Plants.—*Duluth, Minn.*—A press dispatch states that a representative of the Edison Electric Co. is examining the St. Louis River water-power with a view to utilizing it for electric transmission to manufactories.

Crawfordsville, Ind.—It is reported that the city will buy an electric light plant, costing about $25,000.

New Companies.—American Electric Machinery Co., Portland, Me.; capital stock, $100,00; President, D. W. Scribner. Farmville, Va., Electric Light, Heat & Power Co.; capital stock, $100,000; Secretary, J. M. Crute. United Light Co., Uniontown, Pa.; capital stock, $100,000; incorporators, J. K. Ewing, Jr., E. S. Hackney, W. G. Hoysall, and others. Piedmont Construction & Land Co., Seneca, S. C.; capital stock, $20,000; incorporators, W. J. Kirk, A. Zimmerman, J. W. Bowden, and others; company proposes to erect an electric light plant. Danville, Ill., Gas, Electric Light & Street Railway Co.; capital stock, $250,000; incorporators, A. C. Daniel, F. W. Penwell, W. P. Cannon.

CONTRACTING.

Stone and Piles.—*New York, N. Y.*—The Department of Docks has awarded contracts as follows: Beard & Kimpland, $7.50, $7.25, $5.30, and $17 each for piles 65 to 70, 60 to 65, 55 to 60 and 80 to 85 ft. long. D. E. Donovan, $1.58 per cu. yd. and Brown & Fleming $1.55 per cu. yd. for broken stone.

Street Work.—*Peoria, Ill.*—The Street Committee has prepared estimates for street improvements at the following prices: Excavation, 30 cts. per cu. yd.; setting curb, 5 cts per lin. ft.; brick pavement, $1.55 to $1.65 per sq. yd.

Minneapolis, Minn.—The contract for cedar block paving for next season has been awarded to the West Michigan Paving Co. of Muskegon, Mich., at prices ranging from 80 to 86 cts. per yd.

Key West, Fla.—Contracts have been let at the following prices: Brick paving, $2.69 per sq. yd.; bluestone curbing, 4 ins. thick, 4 ft. long, 16 to 20 ins. deep, 91 cts. per lin. ft.; brick gutter, $3.44 per sq. yd.; brick sidewalks, $2 per sq. yd: grading, $1.50 per cu. yd. in excavation; haul over 1,000 ft., 1½ cts. per cu yd. The paving brick to be 7 to 9 ins. long, 2 to 2½ ins. thick, 4 to 4½ ins wide; set on edge; and at street intersections set at an angle of 45° with the street.

Cleveland, O.—Mr. Force, city engineer, has prepared estimates for paving Dodge St. with different materials at the following prices: Stone block, 35 cts. per sq. ft.; brick, 20 cts.; brick on concrete or brick foundation, 28 cts.; Trinidad asphalt, 38½ cts.

Levee.—*New Orleans, La.*—The lowest bid received at the U. S. Engineer Office for the construction of Buckridge levee in the 4th Mississippi levee district, was from Manning & Howe, Lake Providence, La., at 18 cts. per cu. yd.

Brick.—*Washington, Pa.*—The Council has awarded contracts for vitrified paving brick as follows: A. O. Jones & Co., Zanesville, O., 1,000,000 at $13.20 per 1,000; American Fire Clay Co., Toronto, O., 1,000,000 at $13.25; Smith, Porter & Co., West Cumberland, W. Va., 1,000,000 at $13.25; Pittsburg Clay Mfg. Co., New Brighton, Pa., 1,000,000 at $13.50.

Granite Blocks.—*Cambridge, Mass.*—The contract for 300,000 granite paving blocks, 3½ to 4 ins. wide and 7 to 8 ins. long, 7½ to 8 ins. deep, has been awarded to Wilson & Riley, of Quincy and Cambridge, at $39 per 1,000.

Gas.—*Brooklyn, N. Y.*—The Department of City Works has received the following proposals for furnishing gas for street lamps and public buildings during 1891: Williamsburg Gas Light Co., $21 per lamp, $1.50 per 1,000 cu. ft. for buildings. Metropolitan Gas Light Co., Nassau Gas Light Co., Peoples' Gas Light Co. and Citizens' Gas Light Co., $21.25 per lamp, $1.50 per 1,000 cu. ft.; Brooklyn Gas Light Co., $19.80 per lamp, $1.50 per 1,000 cu. ft.

PROPOSALS OPEN.

Bridge.—*Hamilton, O.*—Iron or steel bridge 90 ft. span. The Bridge Commissioners. Jan. 11.

Dams and Dikes.—In the Ohio River. Lt.-Col. Wm. E. Merrill, U. S. Engineer Office, Cincinnati, O. Jan. 22.

Lumber.—To furnish at the Norfolk (Va.) lumber yard, 100,000 ft. of creosoted lumber, 9,000 ft. of mahogany, and 500 ft. of cherry. Edwin Stuart, Paymaster-General, U. S. N., Navy Department, Washington, D. C. Jan. 6.

Building.—*Brooklyn, N. Y.*—Armory for the 13th Regiment. Armory Commissioners, City Hall. Jan. 14.

City Work.—*Brooklyn, N. Y.*—Belgian block pavement and blue stone curbing. Department of City Works. Jan. 9.

Providence, R. I.—Work and materials for 1891, as follows: Concreting, Jan 5; about 2,400 casks of cement, Jan. 6; cast iron pipe, 9 gross tons of 4-in., 538 tons of 6-in., 200 tons of 8-in., 91 tons of 12-in., 36 tons of 30-in., Jan. 8; sewer materials, including pipe and branches, flagstones, catch-basin stones, and 800,000 hard brick, Jan. 13. John A. Coleman, Commissioner of Public Works.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Canadian Locomotive & Engine Co., of Kingston, Ont., has just built 3 ten wheel engines for the Canadian Pacific Ry., cylinders 18 × 24 ins., weight in working order 106,000 lbs.; also 2 similar engines for the Intercolonial Ry.; for the Grand Trunk Ry. it is building 10 mogul engines with cylinders 18 × 26 ins., and weighing 98,000 lbs. It is also building 5 eight-wheel engines, with cylinders 17 × 24 ins., and weighing 86,000 lbs. The Richmond Locomotive & Machine Works, of Richmond, Va., report 25 locomotives built during 1890, in addition to the engines of the U. S. battle-ship *Texas;* 12 consolidation, 5 mogul, and 8 eight-wheel engines. The Rhode Island Locomotive Works, of Providence, R. I., are building 6 four-wheel switch engines for the Boston & Albany R. R. The Portland Co., of Portland, Me., has built an engine for the Kennebec Central R. R. The Dickson Mfg. Co., of Scranton, Pa., is building 17 engines for the Delaware, Lackawanna & Western R. R. The Baldwin Locomotive Works of Philadelphia, Pa., have an order for 27 locomotives for the New South Wales Government Rys.; 10 will be passenger engines weighing 30 tons each.

Cars.—The St. Charles Car Works, of St. Charles, Mo., have built 4 large museum cars. The Pullman Palace Car Co., of Chicago, Ill., has completed 2 sleeping cars for the St. John & Bangor line. The Jackson & Woodin Mfg. Co., of Berwick, Pa., has a contract for 1,000 coal cars for the Delaware, Lackawanna & Western R. R., and 500 coal cars for the Lehigh Valley R. R. The Wagner Palace Car Co., of Buffalo, N. Y., is building 12 sleeping cars, 6 drawing room cars and 2 stateroom cars for the Lake Shore & Michigan Southern Ry. The Columbia Steel Car Co. will build works near Chicago, Ill., between Desplaines and Park Ridge. The Virginia Car Co. will build works at Glasgow, Va., and the Goshen Car & Railway Equipment Co. will build works at Goshen, Va. The American Railway Car Co. has been organized at Denver, Col., to manufacture an improved form of stock car; incorporators, Vidler and Pierce, of Denver, and Geo. B. Pullman. The Hogan Refrigerator Car Co., of Chicago, Ill., has been incorporated by E. J. Johnson, A. Woodward and H. R. Pearson. The Western Rolling Stock & Equipment Co., of Chicago, has been incorporated by Geo. G. Farley, Grant S. Wheeler and Wm. E. W. Johnson; capital stock, $100,000.

Railway Stations.—A brick and stone station will be built at Sheffield, Ala. It will be 50 × 250 ft. The Union Terminal & Warehouse Co. has been organized at Denver, Col., by John B. Walker, E. S. Walker and Joseph A. Thatcher, to build a handsome union depot, and establish freight yards and terminal facilities; capital stock, $1,200,000.

Car Coupler.—An automatic car coupler has been patented by Col. Victor Brett, of Bangor, Me. The drawhead has a fixed link on one side and jaws on the other, the jaws and links of connecting couplers engaging with one another. The pin holding the links can be withdrawn without the brakemen going between the cars.

Companies.—National Water Tube Boiler Co., of New Brunswick, N. J.; capital stock, $100,000. Enterprise Dredging & Transportation Co., of Charleston, S. C.; capital stock, $30,000; incorporators, G. W. Egan, H. L. Cordes and G. F. Buchanan. La Grande Brick & Tile Co., of La Grande, Cal.; capital stock, $10,000; incorporators, C. J. Bunty, Geo. Kreiger and R. E. Bryan. Eureka Pipe Line Co., of Charleston, W. Va., to operate the West Virginia oil field; capital stock, $1,000,000; incorporators, Samuel O'Day, of Buffalo, N. Y.; C. N. Payne, of Titusville, Pa.; R. E. Alexander, of Parkersburg, W. Va. Standard Asphalt Co., of Bakersfield, Cal.; capital stock, $100,000; directors, S. Jewett, H. A. Blodgett, Sutherland Hutton and L. Blankenhorn. Abutment Gate Co., of Chicago, Ill., to manufacture safety gates and other improvements for bridges; capital stock, $300,000; incorporators, E. Leech, H. S. Williams and H. H. Ware. Owen Automatic Signal Co., of Lynchburg, Va.; to manufacture R. O. Owen's patent railway signal; president, C. C. Dunn, Jr.; vice-president, W. H. Wren. Southern Machinery Co., of Atlanta, Ga.; to deal in machinery, railway equipment and supplies. St. Lawrence Bridge Co., of Montreal, Can.; capital stock, $25,000. Ticonic Gas & Ventilating Co., of Waterville, Me.; capital stock. $60,000; president, R. W. Dunn; secretary, W. T. Haines. Beverly Hills Builders' Supply Co., of Chicago, Ill.; capital stock, $10,000; incorporators, F. Bacher, E. Lewerise, and L. Hansler, Jr. Indiana Iron Mining Co., of Chicago, Ill.; capital stock, $1,000,000; incorporators, W. H. Crane, C. T. Browne, M. A. Burdick, and D. W. Proctor.

The Eddy Valve Co., of Waterford, N. Y., has been awarded contracts for valves for the improvements of water-works at Centralia, Wash.; Topeka, Kan.; and Minneapolis, Minn.

Metal Market Prices.—*Rails.*—New York: $28; old rails, $22 for iron and $20 for steel. Chicago: $31 to $31.50; old rails, $23 50 for iron and $17 for steel. Pittsburg: $29 to $29.50; old rails, $26 for iron, and $16.50 to $17 for steel.

Foundry Pig Iron.—New York: $15.50 to $17. Chicago: $15 to $16.25. Pittsburg: $15.25 to $17.

Track Materials.—New York: steel angle bars, $1.65 to $1.75; spikes, $2 to $2.10; track bolts, 2.7 to 2.8 cts. with square, and 3.10 to 3.15 cts. with hexagon nuts. Pittsburg: splice bars, 1.95 to 2.05 cts. for iron, 2 to 2.1 cts. for steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.9 with square, and 3 cts. with hexagon nuts. Chicago: splice bars, 2.05 to 2.1 cts. for iron and 2.15 to 2.20 for steel; spikes, 2.20 to 2.25 cts.; track bolts, 3.1 cts. with hexagon nuts.

Pipe.—Cast iron, $27 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 47½ and 40 per cent. on black and galvanized butt-welded; 60 and 47½ on black and galvanized lap-welded. Casing, 50 per cent.

Lead.—New York, 4.1 to 4.15 cts. Chicago, 4 50 cts. St. Louis, 4.45 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2.20 to 2.25 cts.; tees, 2.65 to 2 75 cts.; sheared iron plates, 2.25 to 2.30 cts.; steel plates, 2.25 to 2.35 for tank, 2.55 to 2.65 cts. for shell, 2.85 to 3 cts. for flange, 3.75 to 4.25 cts. for firebox. Chicago: beams, 3.2 cts.; angles, 2.35 to 2.4 cts.; tees, 2.9 to 3 cts.; universal plates, 2.45 to 2.5 cts.; sheared plates, 2.5 to 2.6 cts. for iron and 2.6 to 2.7 cts. for steel. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2.25 cts.; tees, 2.85 cts.; universal iron mill plates, 2.3 cts.; sheared steel bridge plates, 2.55 cts.; refined bars, 1.9 to 2 cts.; steel plates, 2.35 cts. for tank, 2.75 cts. for shell, 2.95 cts. for flange, 4 to 4.25 cts. for firebox.